Nicolet Models 41/42 Programmable Function Generators

Operation Manual

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WARRANTY

This Product is sold by Nicolet Instrument Corporation under the warranty herein set forth. The warranty is extended only to the buyer purchasing the device direct from Nicolet Instrument Corporation or as a new device from an authorized dealer distributor of Nicolet Instrument Corporation.

Nicolet Instrument Corporation warrants this Product to be free from defects in workmanship and material under normal use and service and shall conform to the description thereof contained in this brochure for a period of one (l) year from the date of delivery. The liability of Nicolet Instrument Corporation under this warranty is limited, at its sole discretion, to replacing, repairing or issuing credit (adjusted to reflect age and use of the Product) for a system or portion thereof returned to Nicolet Instrument Corporation during the warranty period, provided that (a) Nicolet Instrument Corporation is notified in writing within thirty (30) days following discovery of a defect by the buyer, (b) the defective device is returned to Nicolet Instrument Corporation, transportation charges prepaid by buyer, and (c) Nicolet Instrument Corporation's examination of the device shall disclose to its satisfaction that (i) the device has not been repaired or altered by anyone other than Nicolet Instrument Corporation, (ii) any defect has not been caused by misuse, neglect or accident, (iii) the device has not been operated under conditions other than normal use, and (iv) prescribed periodic maintenance and services have been performed with respect thereto.

THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, WHETHER STATUTORY OR OTHERWISE, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL NICOLET INSTRUMENT CORPORATION BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM THE USE OF THE PRODUCT OR CAUSED BY ANY DEFECT, FAILURE OR MALFUNCTION OF THE PRODUCT, WHETHER A CLAIM FOR SUCH DAMAGE IS BASED UPON WARRANTY, CONTRACT, NEGLIGENCE OR OTHERWISE.

NOTE: For G.S.A. customers, (U.S. only), the standard G.S.A. 1 year warranty applies.

SAFETY SUMMARY

The general safety information in this section of the manual is for both operating and servicing personnel.

Terms Used In This Manual

CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.

WARNING statements identify conditions or practices that could result in personal injury or loss of life.

> Do not proceed beyond either **CAUTION** or **WARNING** statements until the indicated conditions are fully understood and met.

Operation

Before applying power, comply with the installation and operating instructions.

Grounding

This product is grounded through the grounding conductor of the power cord. **Do not alter this connection.** Upon loss of the protective ground connection, all accessible conductive parts (including knobs and controls) can render an electric shock.

Additional Precautions

Any adjustment, maintenance, and repair should be performed by qualified personnel only.

To avoid personal injury, do not operate the instrument without its covers and panels installed.

Replacement fuses must be of the same type and rating as the original fuses installed in the instrument. In addition, avoid the use of repaired fuses and the short-circuiting of fuseholders.

Do not perform any unauthorized modifications to the instrument.

Do not operate the instrument in the presence of flammable gases or in explosive atmospheres.

Disconnect the power cord before removing protective panels, soldering, or replacing components.

Do not attempt internal servicing or adjustments to the instrument unless another person capable of rendering first aid and resuscitation is present.

INTRODUCTION

This section contains installation information, power requirements, initial inspection and signal connections for the Model 41 and 42 function generators.

Receiving

Unpack the instrument and save the carton and packing material in case the instrument must be shipped to another site, or returned to the factory for service.

Inspection

Inspect the exterior of the instrument for any visible signs of damage that may have occurred during transit. If damaged, call:
Nicolet Test Instruments Division,
Shipping Department
(608) 271-3333

Inventory the contents of the shipment (accessories, options, etc.). If incomplete, call:
Nicolet Test Instruments Division,
Sales Department
(608) 273-5008.

The acceptance test is located in Section 8 of this manual. If problems occur during the acceptance test, call:
Nicolet Test Instruments Division,
Customer Service Department
(608) 273-5010

INSTRUMENT MOUNTING

The Model 41 and 42 programmable function generators are intended for bench use.

Front Tilt

The instrument includes a front tilt mechanisim for optimum panel viewing.

Cooling Requirements

The instrument does not require special cooling when operated within conventional temperature limits. A 2 inch (5 cm) minimum clearance must be provided at the rear of the unit for proper cooling of the heatsink.

The instrument can be installed in a closed rack or test station if proper air flow is assured to remove approximately 30 watts of power dissipation.

POWER REQUIREMENTS

Both Models can be operated from any source of 90 to 128 VAC, or 180 to 256 VAC (48 to 66 Hz). The maximum power consumption is 50 VA, approximately. Use a slow blow fuse rated as listed on the rear panel of the instrument.

CAUTION: The line power voltage of the instrument is noted on the AC input plug. To guard against damage to the instrument, ensure that the voltage selection and line voltage match, and that the fuse type and rating is correct before applying power to the instrument.

Changing the Line Voltage

To change the line voltage, remove the AC power receptacle and turn the indicator until the desired line voltage (**110V** or **220V**) appears in the window (Figure 3-1).

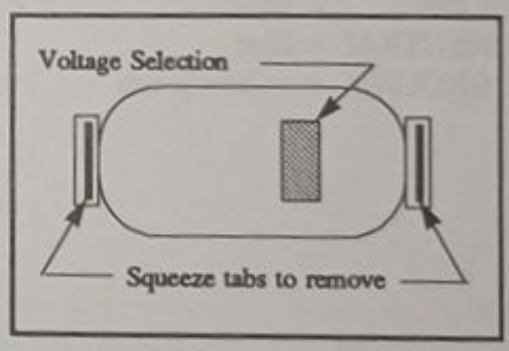


Figure 3-1

Replacing the Fuse

The power fuse is located on the rear panel AC input receptacle.

WARNING: Remove all power from the instrument before removing the fuse.

GROUND REQUIREMENTS

For the safety of personnel, the instrument must be grounded. The center pin on the AC plug grounds the instrument when properly connected to the ground wire and plugged into a proper receptacle.

WARNING: To avoid personnel injury due to shock, the third-wire earth ground must be continuous to the power outlet. Before connecting the power outlet, examine all cables and connections between the unit and the facility power for a continuous earth ground path.

The instrument is supplied with a three-wire power cable. To connect properly, all connections should be carried out by a qualified electrician and meet local safety requirements and codes.

The color code is as follows:

LINE = brown
NEUTRAL = blue
GROUND = yellow/green

SIGNAL CONNECTIONS

Use RG58U (50Ω) or equivalent coaxial cables for all input and output signals to and from the instrument.

OUTPUT
Up to 10 Vp-p into a 50Ω impedance (20 Vp-p into an open circuit.) Protected from short circuit to any voltage between ±100 VAC or VDC.

TRIG IN
10 kΩ impedance, positive slope with internal adjusted level of ±10V (factory selected at +2V). Input protected to ±50V.

SYNC OUT
Symmetrical square wave signal in phase with the main output. TTL levels with a 50Ω source impedance protected from short circuits to any voltage between ±15 VDC.

VCO IN
Voltage control of generator frequency. AC or DC input (0V to 5V) for a 1000:1 frequency change. Protected to ±50V.

SWP OUT - (Model 42 only)
Sweep output with 600Ω source impedance and same waveshape as sweep selected. Protected against short circuit.

ARB. SYNC OUT - (Model 42 only.)
A TTL output clock with 50Ω impedance at the arbitrary waveform rate.

MKR OUT - (Model 42 only.)
Marker output with TTL levels at a rate and duration identical with the programmed "moving" marker.

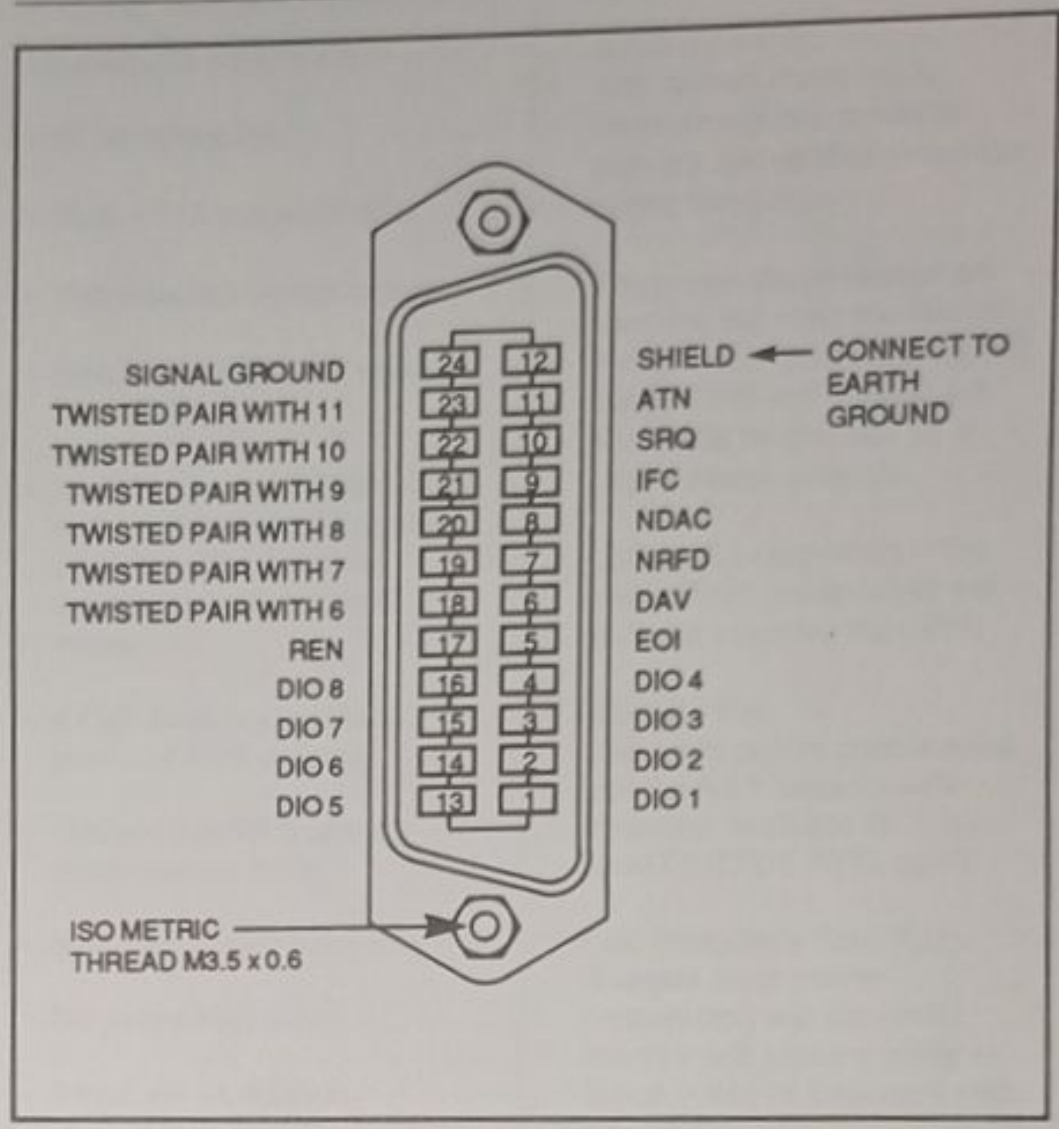
AM INPUT - (Model 42 only.)
5V peak-to-peak for a 100% modulation. The input impedance is 10 kΩ protected against up to a ±50V accidental input, and with a bandwith of DC to 20 kHz minimum.

GPIB CONNECTIONS

The rear panel GPIB connector is an AMPHENOL 57-10240 or equivalent. It connects to a standard IEEE-488 bus cable connector. The GPIB line shields are not isolated from chassis and signal ground.

GPIB ADDRESS

The instrument is shipped with the address set to decimal 7. The address can be changed by an internal switch after removing the instrument covers. See section 7, page 7-5 "Setting the GPIB Address".



24-Pin Micro-Ribbon (Series 57) Connector
Figure 3-2

INTRODUCTION

The Model 41 and Model 42 Programmable Function Generators are designed for ATE and bench top use.

MODEL 41 FEATURES

- 99 stored setups.
- Fully GPIB programmable.
- Fully protected inputs/outputs.
- Sweep-up, down, single or continuous.
- Simultaneous frequency and level displays.
- Modification capabilities which enable parameter shifting about nominal values, threshold measurements and manual sweep.
- 4 digit frequency resolution, providing 0.2% accuracy.
- Optional 0.005% frequency synthesizer accuracy.
- Stored calibration procedure.
- Frequency Modulation.

MODEL 42 FEATURES

- 99 stored set ups.
- Fully GPIB programmable.
- Full protected inputs/outputs.
- Simultaneous frequency and level displays.
- Modification capabilities which enable parameter shifting about nominal values, threshold measurements and manual sweep.
- 4 digit frequency resolution, providing 0.2% accuracy.
- Optional 0.005% frequency synthesizer accuracy.
- Stored calibration procedure.
- Frequency Modulation
- Amplitude Modulation.
- Comprehensive sweep capabilities with linear, logarithmic, and arbitrary sweeps.
- Arbitrary waveform generation.
- Burst mode.
- Dynamic Marker.
  The marker can be dynamically moved up/down during the test without interrupting the test procedure. The marker movement can also be stepped by a predetermined frequency increment for fast access to points of interest over the entire response plot.
- Arbitrary sweep.
  Any desired shape can be programmed into the ARB memory and used to sweep the output frequency.
- Trigger/gate/burst sweeps are standard, but even specialized sweep modes such as Triggered Sweep-Hold and Reverse (or Reset) can be obtained by a proper pattern program.
- Unlimited sweep width. The basic 4000:1 sweep width can easily be extended via GPIB.
- Internal - FM.
  Sine wave pattern programmed into the ARB memory will frequency modulate the front panel OUTPUT BNC signal.
- FSK (Frequency Shift Key).
  A square wave pattern programmed into the ARB memory will perform either a digital sweep or frequency shift key (FSK).

GENERAL DESCRIPTIONS - FRONT PANEL CONTROLS

The general descriptions for the Model 41 (Figure 4-1) and Model 42 (Figure 4-2) are on page 4-3. Refer to Section 6 for detailed descriptions.

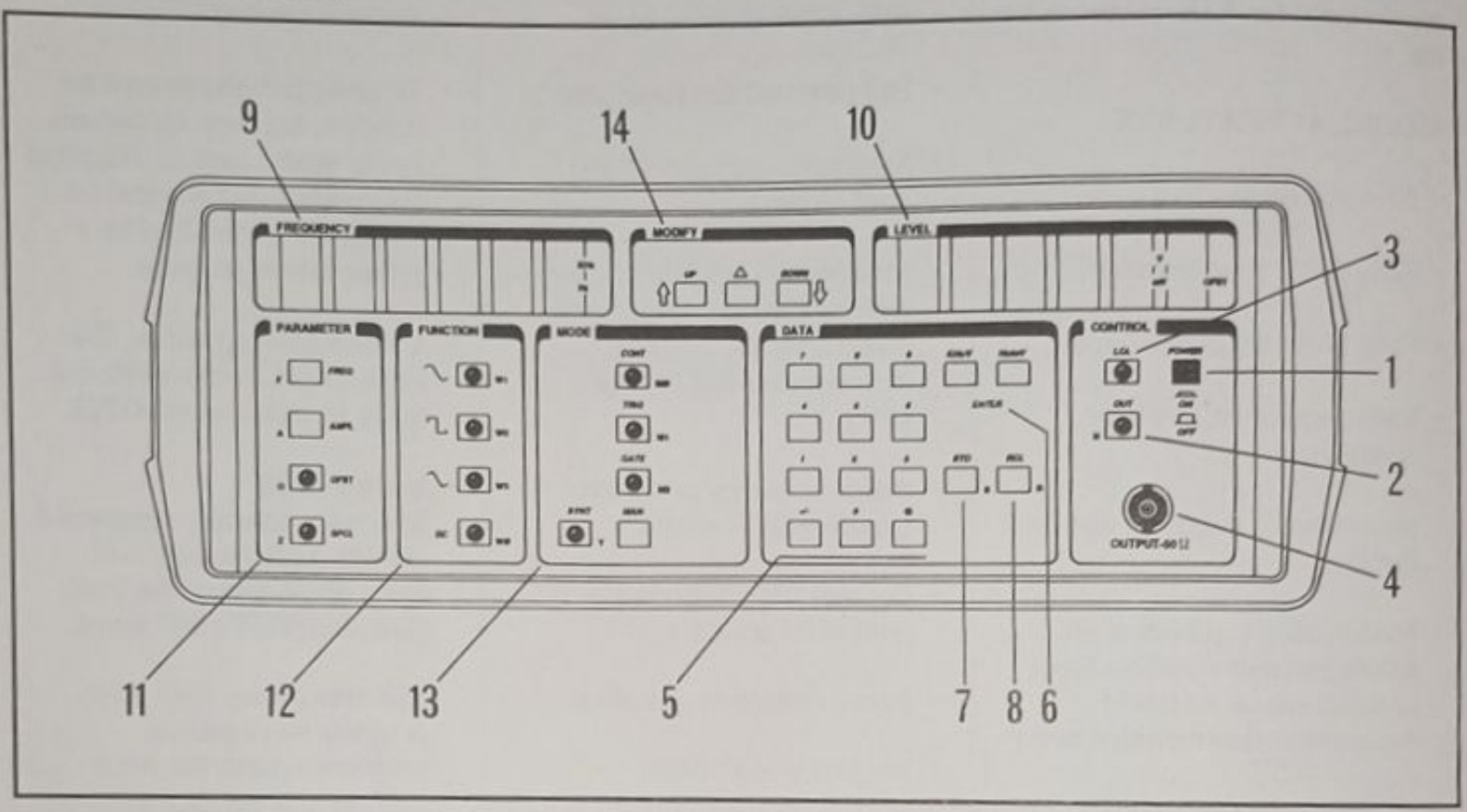


Figure 4-1: (Model 41)

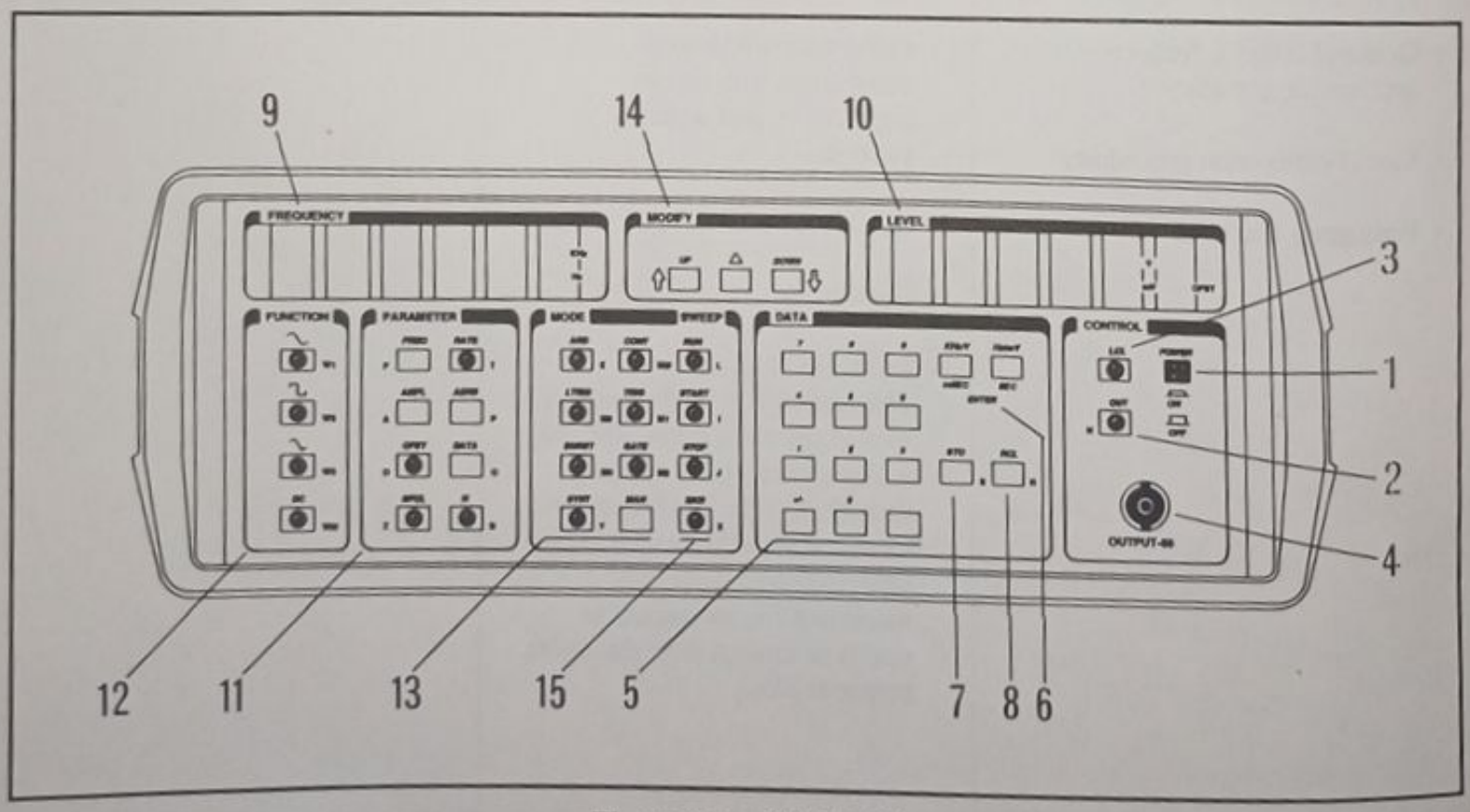


Figure 4-2: (Model 42)

1 - POWER ON-OFF: Applies or removes AC power to the instrument.

2 - OUTPUT ON-OFF: Disables the front panel OUTPUT BNC. The output is turned on when the button's LED is illuminated.

3 - LOCAL BUTTON: Returns the instrument to local manual operation. The internal LED indicates that the unit is under computer control.

4 - MAIN OUTPUT: A 50Ω output BNC connector.

5 - NUMERIC KEYBOARD: Used to enter the numerical value of the selected parameter.

6 - ENTER BUTTONS: The kHz/V and Hz/mV buttons enter a valid parameter during setup and determine the parameter's unit. Every numeric entry must be "Entered" using these buttons.

7 - STORE: Stores the last instrument setup in the the desired memory location.

8 - RECALL: Recalls and activates the setup stored in the selected memory location.

9 - FREQUENCY WINDOW: 4-digit display used to indicate the numerical value and associated unit of the output parameter.

10 - LEVEL WINDOW: 3-digit display used to indicate the numerical value and associated unit of the currently displayed parameter; including the polarity of the offset voltage.

11 - PARAMETER: Selects the enter mode of the following parameters:
(Model 41 & 42) - Frequency, Amplitude, Offset, and Special modes.
(Model 42 only) - Trigger rate, Arbitrary point data and address, Output rate of arbitrary waveforms, and Number of burst cycles.

The OFFSET LED illuminates when the front panel OUTPUT BNC DC offset voltage is not zero.

The SPCL button is used to select special operating modes.

12 - FUNCTION: Selects waveform shape. The selected waveform is identified by an illuminated LED on the button. These functions are mutally exclusive.

13 - MODE: Select continuous, triggered, gated, synthesized, burst (Model 42 only), and arbitrary (Model 42 only) modes.

14 - MODIFY: Select step size (DELTA [Δ] button) and direction of variation (UP and DOWN buttons) of the frequency and amplitude parameters for both models. Positions the marker frequency (Model 42 only).

15 - SWEEP: Model 42 only. Allows the entry of sweep start and stop frequencies, marker frequency, and sweep RUN mode (linear, log or arbitrary). The value of the selected or entered parameter is displayed with its associated unit in the frequency window.

GENERAL DESCRIPTIONS - REAR PANEL BNCs

The general descriptions for the Model 41 (Figure 4-3) and Model 42 (Figure 4-4) are on page 4-5. Refer to Section 6 for detailed descriptions.

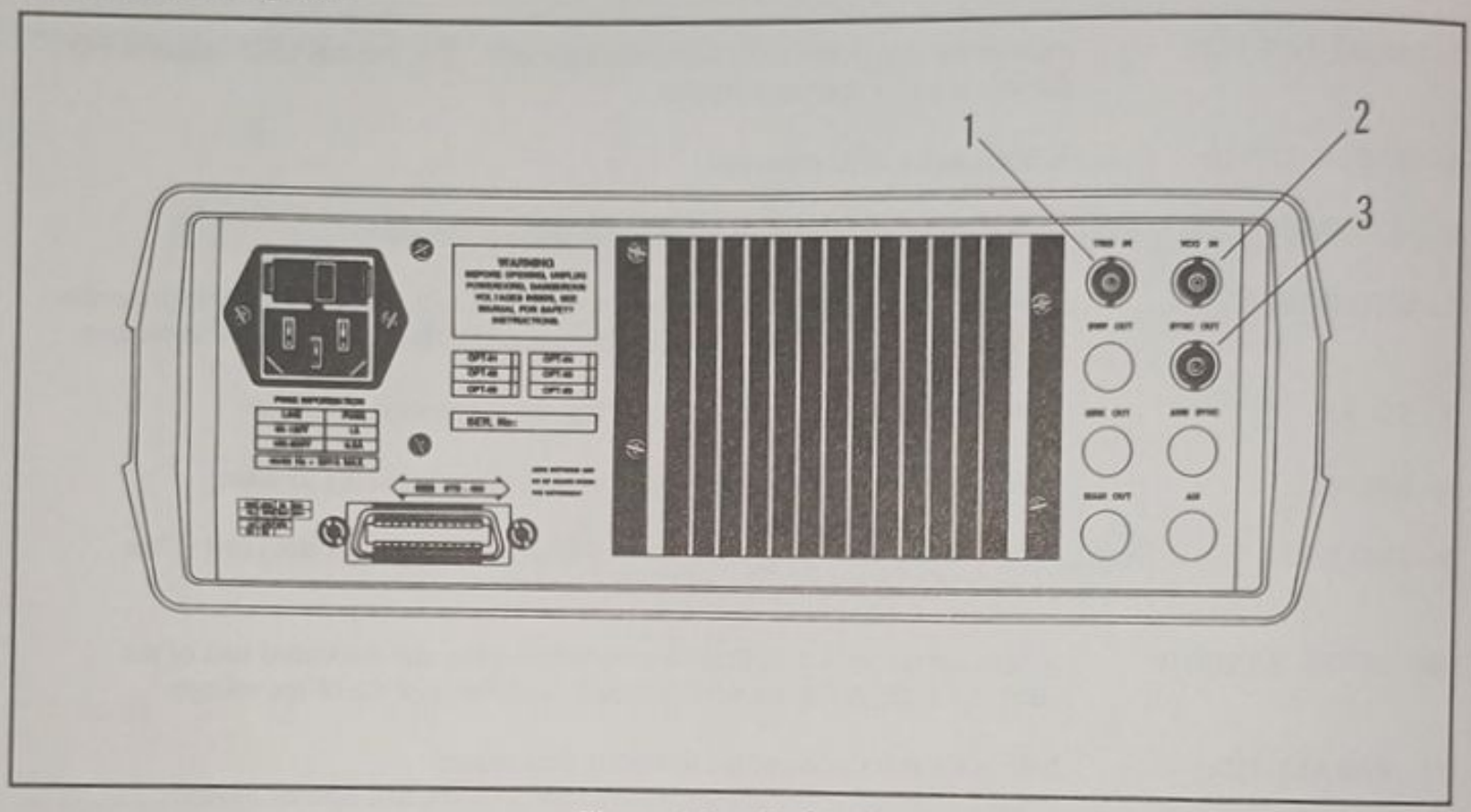


Figure 4-3: (Model 41)

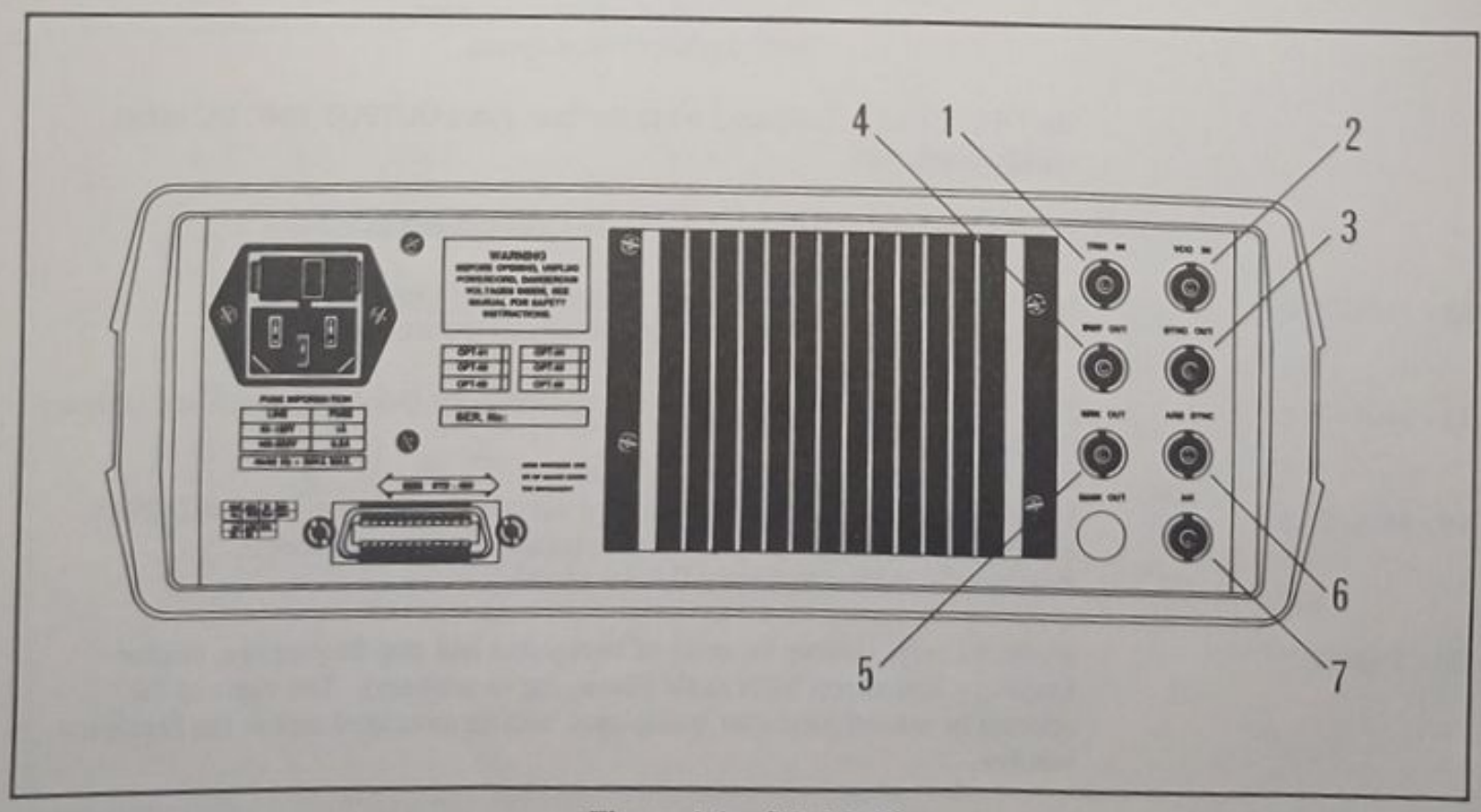


Figure 4-4: (Model 42)

1 - TRIG IN	Input for the external trigger or gate signal.
2 - VCO IN	Increasing voltage increases the output frequency. Decreasing voltage decreases the frequency. Applied signals must be positive voltages only.
3 - SYNC OUT	Outputs a symmetrical squarewave at the same frequency as that of the waveform at the front panel OUTPUT BNC.
4 - SWP OUT (Model 42 only)	Outputs the internal sweep voltage.
5 - MRK OUT (Model 42 only)	Outputs a TTL signal which can be used to synchronize external instruments or used as a PEN LIFT signal for X-Y recorders when operating with a frequency marker.
6 - ARB SYNC (Model 42 only)	Outputs a TTL signal which can be used to synchronize external instruments when operating in the Arbitrary mode.
7 - AM (Model 42 only)	Used to amplitude modulate (AM) the output signal.

START-UP TUTORIAL

NOTE: All descriptions apply to both Models 41 and 42 unless otherwise noted.

> **CAUTION:** Refer to Section 3, pages 3-1 and 3-2 (Power and Ground Requirements) before continuing.

#1. To apply power to the instrument, press the red **POWER** button located near the front panel OUTPUT BNC.

The instrument will perform a Self-Test for 2 seconds (see Section 6, page 6-3) and then default to the following conditions:

a. Frequency window = 1000 Hz
b. Amplitude window = 5.00 V
c. SINE button LED on.
d. CONT button LED on.
e. All other front panel LEDs off.

#2. Set the oscilloscope:
   a. 1 µS Time Per Point for digital scopes (0.1 mS Time Per Division for analog scopes).

   b. ±10 Volts Full Scale for digital scopes (2 Volts Per Division for analog scopes).

   c. Connect the cable from OUTPUT to scope input channel.

#3. Press the **OUT** button located above the front panel OUTPUT BNC. The button's internal LED illuminates when the OUTPUT BNC is turned on.

#4. Adjust the oscilloscope's sensitivity, trigger level, etc. until a 1 kHz sinewave appears on its screen.

FUNCTION BUTTONS

The four front panel Function buttons allow easy selection of sine, square, triangle waveforms or DC level output.

The default is a sine wave output.

#1. Press each of the buttons and observe the screen. The corresponding waveform appears.

#2. Press the SINE button.

NOTE: The default value for the offset is 0 volts. You may not see a displayed offset.

FREQ PARAMETER BUTTON

The FREQ button allows the operator to select the desired frequency of the output waveform.

Program the generator for a 2 kHz output signal.

#1. Press the FREQ button.

#2. Enter 2 using the numerical keypad.

#3. Press the kHz/V button.

The left window displays 2000 Hz and a 2 kHz signal appears on the oscilloscope screen.

IMPORTANT: Numerical values must be entered within 10 seconds after pressing a parameter button in order for the value to be accepted. If "**ERROR 0-1**" is shown then the parameter button must be pressed again and the numerical value entered within 10 seconds. This rule applies for all numerical key entries.

AMPL PARAMETER BUTTON

The AMPL button allows the operator to select the desired amplitude of the output waveform. The entered setting is equal to the peak-to-peak value of the output signal.

Program the generator for a 6 V output signal.

#1. Press the AMPL button.

#2. Enter a 6 via the numerical keypad.

#3. Press the kHz/V button.

The right window displays 6.00 V and a 6 V signal appears on the oscilloscope screen when terminated with 50 ohms.

IMPORTANT: If the output signal is not terminated with 50 ohms, the amplitude and offset will be twice what was specified.

NOTE: See page 6-5 for description of allowable amplitude/offset values.

OFST PARAMETER BUTTON

The OFST button allows the operator to enter a dc offset value.

Enter a -1 V offset:

#1. Press the OFST button.
   a. The right window displays 0 volts (the default offset condition).
   b. The OFST indicator to the right of the window illuminates.

NOTE: The OFST indicator lights whenever an offset value is displayed in the right window.

#2. Press the +/- button located in the lower left corner of the numerical keypad section. A minus sign appears in the right window.

#3. Enter 1 via the keypads.

#4. Press the kHz/V button.
   a. The right window displays -1 V and the waveform is offset by -1 V.
   b. The OFST button's internal LED illuminates.

#5. Press the AMPL button. The selected amplitude (6 V) reappears in the right window.

NOTE: The OFST button's LED remains illuminated when the dc offset voltage is any value other than 0 volts.

#6. Press the OFST button. The selected offset reappears in the right window, verifying that the offset is still set for -1 V.

#7. Return the offset to 0 volts.

#8. Press the AMPL button.

TRIG MODE BUTTON

Selects external triggering when illuminated.

#1. Press the TRIG button.

#2. Apply a 2 volt trigger to the rear panel TRIG IN BNC. One complete cycle is output each time a trigger occurs.

#3. Remove the TRIG IN signal.

#4. Press the MAN (manual trigger) button. Each button press outputs one waveform cycle.

I. TRIG MODE BUTTON

NOTE: Model 42 only.

Selects internal triggering. Signals are output at a rate determined by the front panel **RATE** function.

The default rate is 0.01 kHz (100 mS).

NOTE: Internal triggering is not allowed in the Arbitrary (ARB) or Continuous (CONT) modes.

#1. The TRIG button's LED should still be illuminated.

#2. Press the I. TRIG button.

#3. Press the RATE button. The default value of 0.010 kHz appears in the left window.

#4. Enter 2 via the keypads.

#5. Press the SEC button. The generator outputs one complete cycle every two seconds.

#6. Return the RATE to 0.01 kHz by pressing RATE, entering 0.01, and then pressing mSec.

#7. Press the FREQ button to redisplay the selected frequency.

#8. Press the I. TRIG button, removing the generator from the internal trigger mode.

GATE MODE BUTTON

The front panel output signal can be gated via the front panel MAN button, or via a signal applied to the rear panel TRIG IN BNC.

#1. Press the GATE button.

#2. Set the oscilloscope to 1 mS per point for digital scopes (0.1 S per division for analog scopes).

#3. Press and hold the MAN button, and then release it. The generator outputs a signal for as long as the MAN button is held in.

#4. Set the oscilloscope to 1 µS per point for digital scopes (0.1 mS per division for analog scopes).

#5. Press the CONT button.

BURST MODE BUTTON

NOTE: Model 42 only.

All output waveforms (sine, triangle, square, arbitrary, etc.) can be burst on the Model 42.

The default is two cycles.

Bursting the Output Signal

#1. Press the BURST button.

#2. Press the N button.

#3. Enter 2000 via the keypads.

#4. Press either of the ENTER buttons (the kHz/V or Hz/mV buttons).

#5. Any of the following three methods can be used to burst the output signal for the selected burst length of 2000 cycles.

a. Press the MAN button, or

b. Input a trigger signal to the rear panel TRIG IN BNC, or

c. Press the I. TRIG button for internal triggering.

The generator stops outputting the signal at the end of the 2000th cycle. The next valid trigger will initiate another 2000 cycles.

#6. Press the FREQ button to clear the burst length value from the left window and turn off the N button's internal LED.

#7. Press the CONT button.

SYNT BUTTON

NOTE: The Synthesizer mode is optional. If this option is not installed, and error message (ERROR 4-1) will appear on the front panel digital readouts.

The Synthesizer function locks the output frequency to an internal crystal when the option is installed.

The SYNT button LED flashes when the SYNT feature is NOT installed. It remains illuminated when it is turned on.

FREQUENCY MODULATION

The generator output can be frequency modulated by a positive voltage applied to the rear panel VCO IN BNC.

AMPLITUDE MODULATION

NOTE: Model 42 only.

The generator output can be amplitude modulated by an AC signal input to the rear panel AM input BNC. A 5V peak-to-peak signal allows 100% modulation.

STO & RCL DATA BUTTONS

The STO and RCL buttons allow front panel parameter settings to be stored in memory locations for recall at a later time for fast setups.

Each memory section is designated by two digits: 01 - 99.

Storing Parameter Settings

Store the current front panel settings in memory location 1:

#1. Press the STO button.

#2. Enter 01 via the keypads. The front panel settings are now stored in memory section 01.

#3. Press the Squarewave and TRIG buttons, and change the frequency to 1000 Hz.

#4. Press the STO button.

#5. Enter 02 via the keypads. The current front panel settings are now stored in memory section 02.

Recalling Parameter Settings

Parameters settings stored in any memory section can be recalled instantly for easy setups.

#1. Press the RCL button.

#2. Enter 01 via the keypads. The generator returns to the front panel parameter settings stored in memory location 1.

UP / Δ / DOWN BUTTONS

Frequency and amplitude parameter values can be easily changed about nominal values.

UP Button

#1. Press the FREQ button.

#2. Press and hold in the UP button. The frequency increases at a faster rate after the first 10 steps are completed.

DOWN Button

#1. Press the FREQ button.

#2. Press and hold in the DOWN button. The frequency decreases at a faster rate after the first 10 steps are completed.

DELTA (Δ) Button

The DELTA button allows larger steps. Increment the frequency in steps of 100 counts.

NOTE: For the example (1000 Hz) 100 counts is equal to 100 Hz (1000 + 100 =1100 Hz). If the selected frequency is 5.00kHz a Δ value of 100 will step the frequency in 1kHz increments (5.00 + 100 = 6.00 kHz.)

#1. Press the FREQ button.

#2. Press the DELTA button.

#3. Enter 100 via the keypads.

#4. Press either of the ENTER buttons (KHz/V or Hz/mV).

#5. Press the FREQ button.

#6. Press and hold the UP button. The frequency changes in steps of 100.

#7. Press RCL and enter 01.

ERRORS CODES

The digital readouts display error codes when erroneous operations are attempted.

For example:

#1. Press the SPCL button.

#2. Press the OFST button. The message **ERROR 0-1** appears in window indicating a syntax error occurred.

The error message times out after 2 seconds. It can also be cleared manually by pressing a parameter button.

Refer to Section 6, page 6-21 for a complete listing of error codes.

NOTE: If a wrong parameter button is pressed and you wish to clear the selection, press the FREQ or AMPL button to clear the selection.

For example,

#1. Press the RATE button. The RATE button LED illuminates and the left window displays 0.010 kHz.

#2. Press the RATE button again. The generator does not respond.

#3. Press the FREQ button. The RATE LED turns off and the left window returns to the current frequency setting.

ARB BUTTON

NOTE: Model 42 only.

The arbitrary waveform mode allows the operator to design unique waveform outputs.

Arbitrary waveforms can be entered and edited via the front panel buttons or via the GPIB computer interface.

Since arbitrary waveform editing is particularly easy, several standard waveforms can be entered into the arbitrary memory to be used as foundations for your editing ideas.

NOTE: Refer to the built-in slide chart for the arbitrary editing codes.

BUILT-IN ARBITRARY WAVEFORMS

Some basic waveforms have been implemented for fast and easy entry. These waveforms can be modified to suit a particular application.

NOTE: The SPCL button is not functional when the ARB button is illuminated. Turn ARB off before attempting to use the special codes.

Scope Setup

#1. On the oscilloscope, select 10 µS Time Per Point for digital scopes (1 mS Time Per Division for analog scopes).

• TRIANGLE WAVE (SPCL 712)

Enters a triangle waveform (360 pts/cycle).

#1. Press the SPCL button.

#2. Enter 712 via the keypads.

#3. Press the ARB button to view the waveform, and then once again to turn the ARB mode off.

• POSITIVE RAMP (SPCL 713)

Displays a positive-going sawtooth (360 pts/cycle).

#1. Press the SPCL button.

#2. Enter 713 via the keypads.

#3. Press the ARB button to view the waveform, and then once again to turn the ARB mode off.

• NEGATIVE RAMP (SPCL 714)

Enters a negative-going sawtooth (360 pts/cycle).

#1. Press the SPCL button.

#2. Enter 714 via the keypads.

#3. Press the ARB button to view the waveform, and then once again to turn the ARB mode off.

• SINEWAVE (SPCL 710)

Displays a highly stabilized sinewave (360 pts/cycle).

#1. Press the SPCL button.

#2. Enter 710 via the keypads.

#3. Press the ARB button to view the waveform, and then once again to turn the ARB mode off.

• SQUAREWAVE (SPCL 711)

Enters a squarewave (360 pts/cycle).

#1. Press the SPCL button.

#2. Enter 711 via the keypads.

#3. Press the ARB button to view the waveform, and then once again to turn the ARB mode off.

ARB BUTTON

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#2. Enter 713 via the keypads.

#3. Press the ARB button to view the waveform, and then once again to turn the ARB mode off.

• NEGATIVE RAMP (SPCL 714)

Enters a negative-going sawtooth (360 pts/cycle).

#1. Press the SPCL button.

#2. Enter 714 via the keypads.

#3. Press the ARB button to view the waveform, and then once again to turn the ARB mode off.

• SINEWAVE (SPCL 710)

Displays a highly stabilized sinewave (360 pts/cycle).

#1. Press the SPCL button.

#2. Enter 710 via the keypads.

#3. Press the ARB button to view the waveform, and then once again to turn the ARB mode off.

• SQUAREWAVE (SPCL 711)

Enters a squarewave (360 pts/cycle).

#1. Press the SPCL button.

#2. Enter 711 via the keypads.

#3. Press the ARB button to view the waveform, and then once again to turn the ARB mode off.

Selecting the Desired Waveform Amplitude

To reach the desired waveform amplitude for each point when designing waveforms in the Basic, Auto-Increment, and Auto-Decrement modes, note that -

a. Level 2000 (out of 4000 points resolution) is defined as the zero baseline. See Figure 5-1.

b. Each resolution point corresponds to a 2.5 mV output if the amplitude is set to the maximum value of 9.99 volts into 50 ohms. It is proportionally attenuated for lower output amplitudes. For example, each point will be 1.25 mV if the output amplitude is set to 5 volts.

c. The final amplitude can be set using the front panel amplitude, offset and modify controls.

IMPORTANT: The displayed amplitude setting refers to the max. voltage peak-to-peak, i.e. level 0 to level 3999. If the arbitrary waveform is smaller than full scale then the displayed amplitude will not represent the peak-to-peak voltage.

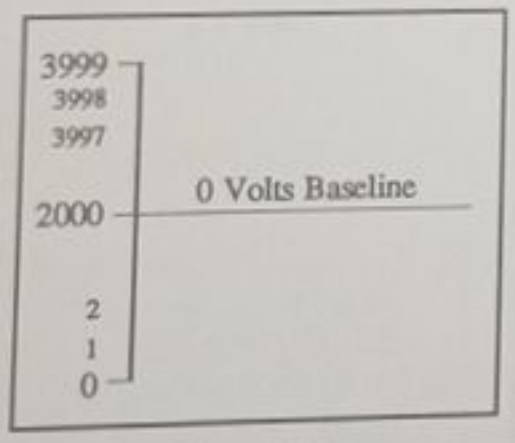

Figure 5-1

Oscilloscope Setup

Set the oscilloscope to 5 µS/pt for digital scopes (0.5 mS/div for analog scopes).

BASIC EDITING MODE

Points are defined by entering an address and entering the desired data level.

NOTE: The following example will modify the resident squarewave (SPCL 711) last selected in the previous section.

#1. Press the SPCL button.

#2. Enter 701 via the keypads.

#3. Press the ADRS button.

#4. Enter 101 (via the keypads) to select address location 101.

#5. Press either ENTER button.

#6. Press the DATA button.

#7. Enter an amplitude level of 3000 via the keypads.

#8. Press either the kHz/V or Hz/mV button.
An amplitude level of 3000 is stored in memory location 101.

#9. Repeat steps #3 through #8 for each of the amplitude levels listed in Table 5-1

#10. Press the SPCL button.

#11. Enter 701 via the keypads to exit the arbitrary mode.

#12. Press the ARB button to view the constructed waveform on the oscilloscope screen.
A waveform similar to Figure 5-2 should be displayed.

#13. Press the ARB button to exit the arbitrary mode.

ADDRESS NUMBER	LEVEL TO BE ENTERED
101	3000
102	3000
103	3000
104	3000
105	3000
106	3000

Table 5-1

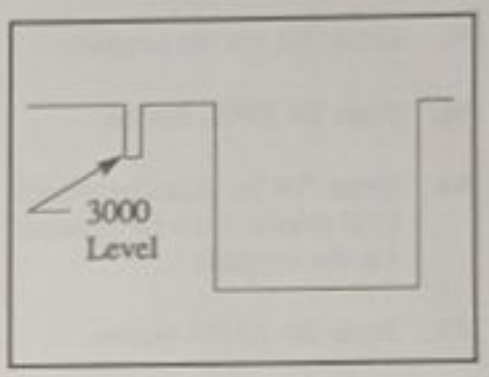

Figure 5-2

AUTO-INCREMENT (704) AUTO-DECREMENT (705) MODES

The memory address location increments/decrements automatically by one after each data level is entered into memory.

The Auto-Increment mode will be used in this example.

#1. Press the SPCL button.

#2. Enter 701 via the keypads.

#3. Press the SPCL button.

#4. Enter 704 for Auto-Increment (705 selects Auto-Decrement) via the keypads.

#5. Press the ADRS button.

#6. Enter 100. This selects address 100 as the starting address.

#7. Press either ENTER button. Address 100 is now locked in as the start address.

#8. Press the DATA button.

#9. Enter 2000.

#10. Press either ENTER button. An amplitude value of 2000 is stored in memory address 100, and the generator increments to address 101 automatically.

Repeat steps #8 through #10 for each of the amplitude values listed in Table 5-2.

#11. Press the SPCL button.

#12. Enter 701 via the keypads.

#13. Press the ARB button. A waveform similar to the one in Figure 5-3 should appear.

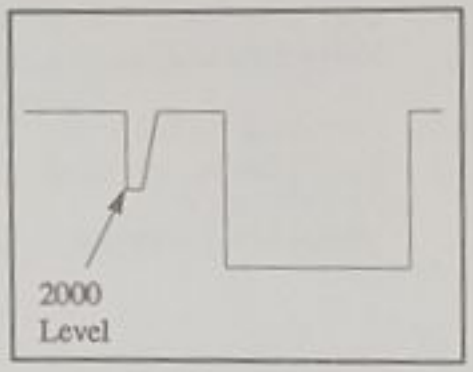

Figure 5-3

ADDRESS NUMBER	VALUE TO BE ENTERED
101	2000
102	2000
103	2000
104	2000
105	2000
106	2000
107	2000
108	2000
109	2000
110	2000
111	2100
112	2200
113	2300
114	2400
115	2500
116	2600
117	2700
118	2800
119	2900
120	3000
121	3100
122	3200
123	3300
124	3400
125	3500
126	3600
127	3700
128	3800
129	3900

Table 5-2

SELECTING THE ARB WAVEFORM AMPLITUDE

The output amplitude is selected in the same manner as when operating in the nonarbitrary mode.

Set the amplitude for 4 volts.

#1. Press the AMPL button.

#2. Enter 4.

#3. Press the kHz/V button. The generator outputs a 4 volt signal.

NOTE: The above description is true for arbitrary waveforms with data levels ranging from 0 to 3999. If the data value range is less than the full 4000 then the selected amplitude will not reflect the actual voltage peak-to-peak. It is possible to calculate the proper amplitude setting for this situation:

$$\text{Amplitude Setting} = \frac{(4000 \times \text{Desired Amplitude})}{(\text{data value range of waveform})}$$

but it may be just as easy to select it by trial and error.

SELECTING THE ARB WAVEFORM FREQUENCY

NOTE: The FREQ button is not functional in the ARB mode.

The RATE button is used to select the point output rate (0.001 mS to 999.9 seconds) for arbitrary waveforms.

The default point rate is 0.01 mS.

Select a point rate of 0.02 mS.

#1. Press the RATE button.

#2. Enter 0.02. **NOTE:** The leading zeros must be entered.

#3. Press the mSEC button. A waveform similar to Figure 5-4 should be displayed.

#4. Press the ARB button to exit the arbitrary mode.

#5. Press the FREQ button to return to the frequency display and turn off the RATE button's LED.

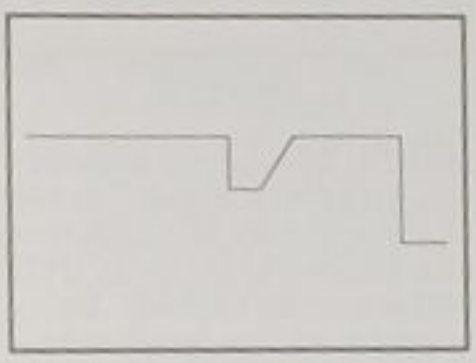

Figure 5-4

Calculating the ARB Waveform's Period

The ARB waveform's period is calculated by Equation 5-1.

$$T_{ARB} = N \times RATE$$

N = number of waveform points.
Rate = point rate

Equation 5-1

SELECTING PARTIAL ARB WAVEFORMS

When only a certain portion of an arbitrary waveform is required, the Model 42 allows the selection of start and stop points.

Start Point

Set the start point at address location 98.

#1. Press the SPCL button.

#2. Enter 701 via the keypads.

#3. Press the ADRS button.

#4. Enter 98.

#5. Press either of the ENTER buttons.

#6. Press the SPCL button.

#7. Enter 702 via the keypads.

Continue with the next section to select the stop point.

Stop Point

Set the stop point address location to 130.

#1. Press the ADRS button.

#2. Enter 130.

#3. Press either of the ENTER buttons.

#4. Press the SPCL button.

#5. Enter 703.

#6. Press the SPCL button.

#7. Enter 701.

#8. Press the ARB button. A waveform similar to Figure 5-5 should be displayed.

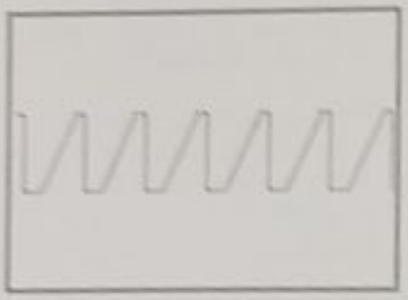

Figure 5-5

NOTE: Start and stop addresses can be entered at anytime. As with the other arbitrary editing functions, it is important to first key in SPCL 701 to enter the edit mode. Be careful to place the correct address on the display before entering SPCL 702 or SPCL 703.

SELECTING THE OUTPUT MODE

The arbitrary signal can be output in four different ways.

Continuous Output

For a continuous waveform output, press the CONT button.

Triggered Output

For a single cycle, press the TRIG button and input a trigger signal to the rear panel TRIG IN input BNC.

Gated Output

For a gated output, press the GATE button and input a signal to the rear panel TRIG IN input BNC. The generator will output the waveform for the duration of the Gate signal.

Burst Output

Outputs a selected number of cycles when triggered either by a signal input to the rear panel TRIG IN BNC or by pressing front panel MAN button.

Set the generator to burst an output of 9000 cycles.

#1. Press the BURST button, the N button, and then enter 9000.

#2. Press either of the ENTER buttons.

#4. Press the MAN button. The generator outputs 9000 cycles of the arbitrary waveform and then stops.

#5. Press the ARB button to exit the arbitrary waveform mode.

#6. Press RCL and enter 01 to continue with this setup procedure.

SELECTING PARTIAL ARB WAVEFORMS

When only a certain portion of an arbitrary waveform is required, the Model 42 allows the selection of start and stop points.

Start Point

Set the start point at address location 98.

#1. Press the SPCL button.

#2. Enter 701 via the keypads.

#3. Press the ADRS button.

#4. Enter 98.

#5. Press either of the ENTER buttons.

#6. Press the SPCL button.

#7. Enter 702 via the keypads.

Continue with the next section to select the stop point.

Stop Point

Set the stop point address location to 130.

#1. Press the ADRS button.

#2. Enter 130.

#3. Press either of the ENTER buttons.

#4. Press the SPCL button.

#5. Enter 703.

#6. Press the SPCL button.

#7. Enter 701.

#8. Press the ARB button. A waveform similar to Figure 5-5 should be displayed.

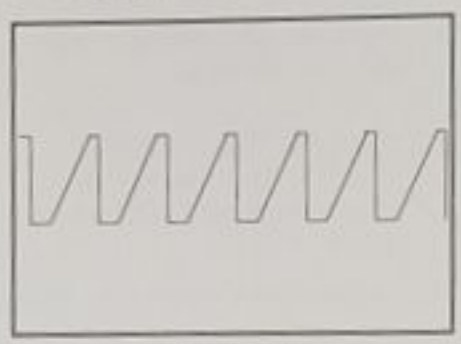

Figure 5-5

NOTE: Start and stop addresses can be entered at anytime. As with the other arbitrary editing functions, it is important to first key in SPCL 701 to enter the edit mode. Be careful to place the correct address on the display before entering SPCL 702 or SPCL 703.

SELECTING THE OUTPUT MODE

The arbitrary signal can be output in four different ways.

Continuous Output

For a continuous waveform output, press the CONT button.

Triggered Output

For a single cycle, press the TRIG button and input a trigger signal to the rear panel TRIG IN input BNC.

Gated Output

For a gated output, press the GATE button and input a signal to the rear panel TRIG IN input BNC. The generator will output the waveform for the duration of the Gate signal.

Burst Output

Outputs a selected number of cycles when triggered either by a signal input to the rear panel TRIG IN BNC or by pressing front panel MAN button.

Set the generator to burst an output of 9000 cycles.

#1. Press the BURST button, the N button, and then enter 9000.

#2. Press either of the ENTER buttons.

#4. Press the MAN button. The generator outputs 9000 cycles of the arbitrary waveform and then stops.

#5. Press the ARB button to exit the arbitrary waveform mode.

#6. Press RCL and enter 01 to continue with this setup procedure.

SWEEP MODE SETUP

NOTE 1: Model 42 only.

NOTE 2: See page 6-11 for additional procedures for internal sweeps which apply to Models 41 and 42.

The output frequency sweeps can be linear, logarithmic, or arbitrary.

Preliminary Setup

#1. Connect the front panel output BNC to the oscilloscope's Y-input BNC.

#2. Connect the rear panel SWEEP OUT BNC to the oscilloscope's X-input BNC.

#3. Setup the oscilloscope for an XY display.

Sweep Start Setup

#1. Press the START button.

#2. Enter 1000.

#3. Press the Hz/mV button.

Sweep Stop Setup

#1. Press the STOP button.

#2. Enter 3999.

#3. Press Hz/mV button.

Point Rate Setup

#1. Press the RATE button.

#2. Enter 0.01.

#3. Press the kHz/V button.

NOTE: The built-in linear and log sweeps are composed of 1000 points. The duration of one complete linear or logarithmic sweep is equal to 1000 x rate.

Marker Frequency Setup

#1. Press the MKR button.

#2. Enter 1500.

#3. Press the Hz/mV button.

NOTE: To delete an existing marker:

a. Press RUN and enter a 0.

b. Press MKR and enter a 0.

c. Press either of the ENTER buttons.

Sweep Run Setup

#1. Press the RUN button.

#2. Enter one of the following numbers. A short delay passes before the signal is output.
1 = linear sweep
2 = log sweep
3 = arbitrary waveform.
0 = sweep off.

NOTE: To change any of the settings, the sweep must be turned off (**RUN, 0**).

#3. A display similar to the one shown in Figure 5-6 should be present, adjust the oscilloscope's gain, sensitivity, etc. as required. The important feature here is to observe the displayed marker.

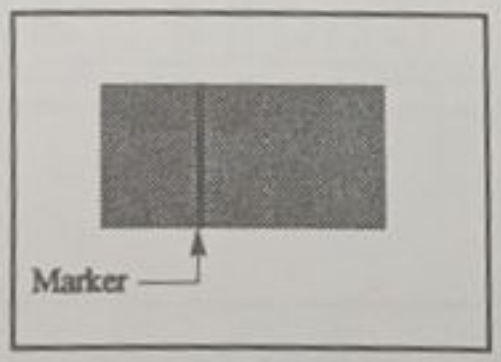

Figure 5-6

Moving the Marker

To move the marker for inspection of the waveform -

NOTE: Sweeping must be activated (RUN1, RUN2) in order to move the marker.

#1. Press the MKR button.

#2. Press and hold the UP button. The marker increments the first 10 steps at a slow and then accelerates to the fast rate.

#3. Release the UP button.

#4. Press and hold the DOWN button. The marker decrements the first 10 steps at a slow rate and then accelerates to a faster rate.

#5. Release the DOWN button.

#6. Press the RUN button and enter 0 to exit the Run mode.

#7. Press the MKR button.

#8. Press the DELTA (Δ) button.

#9. Enter 20 to select steps of 20.

#10. Press either of the ENTER buttons.

#11. Press the RUN button.

#12. Enter 1.

#13. Press the MKR button.

#14. Press the UP button. The marker increments in steps of 20.

#15. Press the RUN button.

#16. Enter 0.

SPCL BUTTON

In addition to the functions of the SPCL button previously discussed, the following information can be obtained by entering the appropriate numbers.

#1. Press the SPCL button.

#2. Enter the first number listed in Table 5-3.

#3. Repeat step #1 for each additional number to be entered from Table 5-3.

ENTER NUMBER	INFORMATION DISPLAYED IN WINDOWS
888	All of the front panel LEDs and digital readout segments illuminate.
488	The GPIB address is displayed in the left window.
101	Displays the frequency Δ increment factor.
102	Displays the amplitude Δ increment factor.
103	Displays the offset Δ increment factor.
104	Model 42 only. Displays the marker Δ increment factor.
200	Frequency locking circuit on/off.

Table 5-3

FRONT PANEL CONTROLS

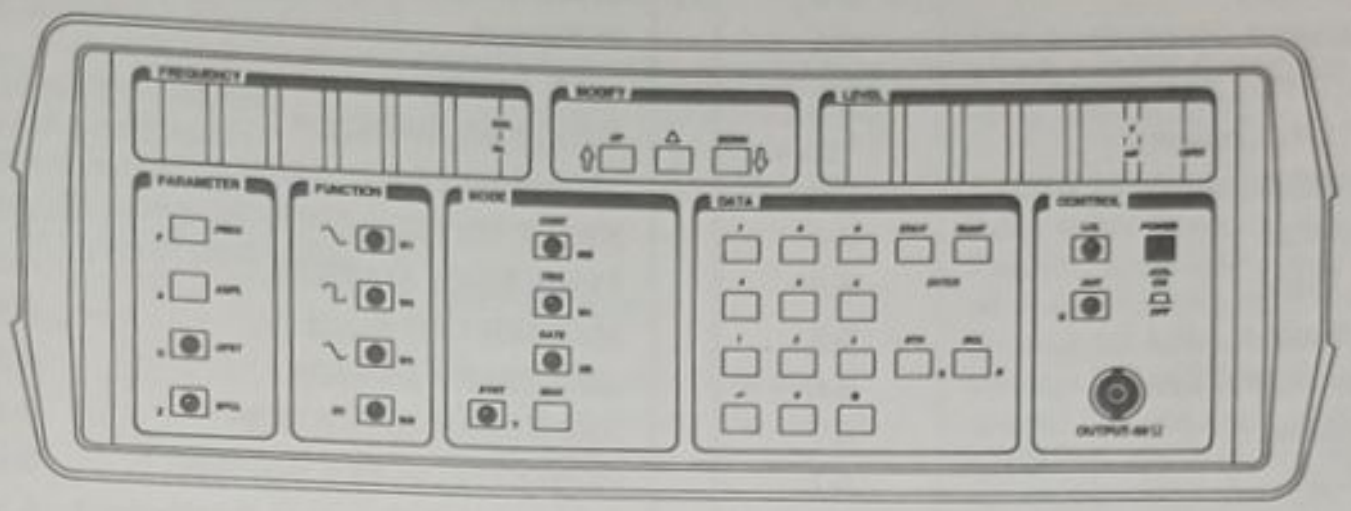

Figure 6-1: Model 41

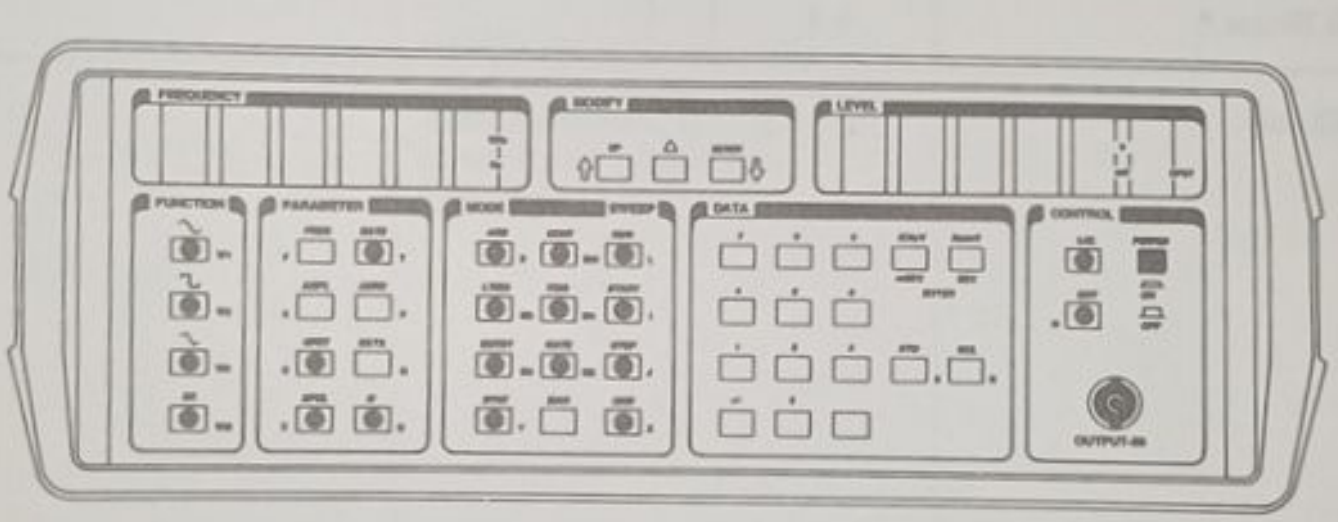

Figure 6-2: Model 42

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• Model 42 only.

• Model 42 only.

INTRODUCTION

Operating modes and parameters can be set either by the front panel controls or programmed using the IEEE-488 interface. The remote mode is activated when the LCL button is illuminated.

Selected parameters, mode of operation, and functions are identified by either the 7-segment LED display (frequency and level windows), or by illuminated LEDs.

SELF-TEST

The generator performs a self-test for 2 seconds when power is initially applied. The self-test is indicated when all of the front panel LEDs are illuminated.

NOTE: If power is removed from the instrument, wait a few seconds before reapplying power or the instrument may bypass the self-test sequence.

Start-Up Defaults

The generator defaults to the following conditions after the self-test sequence times out.

FREQUENCY:	1 kHz
AMPLITUDE:	5V
OFFSET:	0V
MODE:	Continuous
FUNCTION:	Sine
MAIN OUTPUT:	Off

NOTE: The output is disabled to guard against damage to externally connected loads or devices when power is first applied to the generator.

DATA ENTRY

The numerical keyboard enters parameter values and signs, selects increment sizes, accesses the memory, and selects special modes.

Data is entered and executed after pressing one of the ENTER buttons (kHz/V and Hz/mV).

IMPORTANT: Parameter value entry is timed. For example, if you take longer than 10 seconds to select a value after pressing the AMPL button, error message **"ERROR 0-1"** will appear. The sequence must be completed within 10 seconds to successfully enter the value.

If the parameter value entered is beyond specified limits, error message **"ERROR 1-1"** is displayed.

When entering data it may be necessary to use specific units (ENTER keys) for the value to be accepted. For example, 5000 Hz must be entered as 5kHz.

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INTRODUCTION

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Selected parameters, mode of operation, and functions are identified by either the 7-segment LED display (frequency and level windows), or by illuminated LEDs.

SELF-TEST

The generator performs a self-test for 2 seconds when power is initially applied. The self-test is indicated when all of the front panel LEDs are illuminated.

NOTE: If power is removed from the instrument, wait a few seconds before reapplying power or the instrument may bypass the self-test sequence.

Start-Up Defaults

The generator defaults to the following conditions after the self-test sequence times out.

FREQUENCY:	1 kHz
AMPLITUDE:	5V
OFFSET:	0V
MODE:	Continuous
FUNCTION:	Sine
MAIN OUTPUT:	Off

NOTE: The output is disabled to guard against damage to externally connected loads or devices when power is first applied to the generator.

DATA ENTRY

The numerical keyboard enters parameter values and signs, selects increment sizes, accesses the memory, and selects special modes.

Data is entered and executed after pressing one of the ENTER buttons (kHz/V and Hz/mV).

IMPORTANT: Parameter value entry is timed. For example, if you take longer than 10 seconds to select a value after pressing the AMPL button, error message **"ERROR 0-1"** will appear. The sequence must be completed within 10 seconds to successfully enter the value.

If the parameter value entered is beyond specified limits, error message **"ERROR 1-1"** is displayed.

When entering data it may be necessary to use specific units (ENTER keys) for the value to be accepted. For example, 5000 Hz must be entered as 5kHz.

OUT BUTTON

The front panel, 50Ω OUTPUT BNC is used to output signals to external devices. The output is disabled when power is applied initially to the instrument.

To output signals from the front panel OUTPUT BNC, press the **OUT** button. The **OUT** button's LED illuminates when the OUT BNC is enabled.

NOTE 1: The 50Ω output of generator must be terminated with a 50Ω shunt for the displayed amplitude to be correct. If a high impedance termination is used (such as direct input to most oscilloscopes) the actual output voltage will be twice the displayed amplitude.

NOTE 2: If an overload condition occurs at the front panel BNC, the BNC is disconnected and a blinking error message "**ERROR 5-1**" appears.

FUNCTION CONTROLS

The four Function buttons allow the operator to select sine, square or triangle waveforms, or a dc output (see OFST button, page 6-5) by pressing the appropriate button. These functions are mutually exclusive.

READOUT DISPLAYS

The generator uses two LED readouts to display the numerical value of the selected parameters and error messages.

Left Window

The generator frequency is displayed in the left window with a 4-digit readout. The selected unit (Hz or kHz) illuminates on the display.

Model 42 only. The left window also displays the following parameters:

a. Rate (kHz = msec, Hz = sec)
b. Address
c. N count
d. Sweep start, stop and marker.

Right Window

The output level and offset are displayed in the right window with a 3-digit readout. A negative offset voltage is indicated by a minus sign preceding the value.

Model 42 only. The right window also displays the arbitrary data values stored in the selected ARB memory location.

FREQ BUTTON

The Frequency button (in conjunction with the numerical keypad and ENTER buttons) allows the operator to select the output frequency.

The Modify (UP and DOWN) buttons can be used to increment/decrement the selected frequency in single steps, or in multiple steps as programmed by the DELTA button.

To select a frequency, press the **FREQ** button, enter the numerical value, and then press the appropriate **ENTER** button for the desired unit.

Example
To set a frequency of 400 Hz:
#1. Press the FREQ button.
#2. Enter 400
#3. Press the Hz/mV button.

The function generator will accept frequency inputs of 0.004 Hz to 3999 kHz in a 3-3/4 digit format.

The maximum allowable entry is 3999 (regardless of the chosen range). To select a larger frequency, use the next range, i.e. enter 5000 Hz as 5 kHz.

The frequency selected will be automatically allocated in the best performance range, with proper units displayed in the frequency window.

NOTE: Selections such as 0.1 Hz must have a zero entered before the decimal point or **ERROR 0-1** will result.

AMPL BUTTON

The Amplitude button (in conjunction with the numerical keypad and ENTER buttons) allows the operator to select the output amplitude. The amplitude setting is equal to the peak-to-peak voltage when 50 ohm termination is used. High impedance termination will double the actual amplitude voltage.

The Modify (UP and DOWN) buttons can be used to increment/decrement the selected amplitude in single steps, or in multiple steps as programmed by the DELTA button.

To select the amplitude, press the **AMPL** button, enter the numerical value, and then press the appropriate **ENTER** button for the desired unit.

Example
To set an amplitude of 2.10 V:
#1. Press the AMPL button.
#2. Enter 2.10
#3. Press the kHz/V button.

The amplitude programmed must be from 10 mVp-p to 9.99 Vp-p with a resolution of 3 digits.

As with frequency, amplitude programming is in a floating format, and the instrument will select the best performance range.

NOTE: See the amplitude/offset limitations listed in the next section.

OFST BUTTON

The Offset button (in conjuction with the numerical keypad and ENTER buttons) allow the operator to enter an offset voltage. The offset voltage setting will be correct if 50 ohm termination is used. High impedance termination will double the actual offset voltage.

NOTE: The OFST button's LED remains illuminated if the offset is set to any value other than zero volts.

The Modify (UP and DOWN) buttons can be used to increment/decrement the selected offset in single steps, or in multiple steps as programmed by the DELTA button.

It is not possible to change the sign (+,-) of the offset by use of the Modify buttons. The offset can be incremented or decremented, but cannot cross through 0 volts.

To select an offset, press the **OFST** button, enter the numerical value, and then press the appropriate **ENTER** button for the desired unit.

Example
To set an offset of -1 V:
#1. Press the OFST button.
#2. Enter -1
#3. Press the kHz/V button.

The offset programmed must be from -5V to +5V (into 50 ohms).

NOTE: Offset settings such as 0.1 V must have a zero entered before the decimal point or **ERROR 0-1** will result.

IMPORTANT: The sum of the absolute peak amplitude plus the offset has predefined limits.

Amplitude Settings (Vp-p)	Max. Vpeak plus Offset
1.00 V - 9.99 V	4.9[illegible] V
100 mV - 999 mV	499 mV
10 mV - 99 m[illegible]	49 mV

Table 6-1

Attempting to exceed these predefined limits results in **ERROR 1-2.**

For example, if the amplitude is set to 500 mV, an offset of 250 mV is not allowed :
500 mVp-p = 250 mVp,
250 mVp + 250 mV = 500 mV.

500 mV exceeds the allowable limt of 499 mV (see Table 6-1).

UP / Δ / DOWN BUTTONS

The Modify buttons; UP, DOWN, and Δ (DELTA) are used to increment/decrement the selected parameter about nominal values. These buttons are used in conjunction with the FREQ, AMPL, and OFST buttons (both Models); and the ADRS and MKR buttons (Model 42 only).

Stepping Action

The selected parameter value steps one unit each time the UP or DOWN button is tapped.

Example

#1. Press the FREQ button.

#2. Tap the UP button. The frequency readout increments one unit each time the button is pressed.

Continuous Action

The selected parameter value steps ten units at a 0.5 second rate per step, and then speeds up to a rate of 100 mS per step when the UP or DOWN button is pressed and held.

Example

#1. Press the FREQ button.

#2. Press and hold the UP button. The frequency readout increments at a slow rate for the first ten steps and then increments at a faster rate.

Defining the Step Size

Selected parameter values can be incremented/decremented in larger steps.

To define the step size, select the desired parameter, press the **DELTA** button, enter the value, and then press either **ENTER** button.

Example

To define a step size of 50:

#1. Press the FREQ button.

#2. Press the Δ (DELTA) button.

#3. Enter 50

#4. Press either ENTER button.

NOTE: The increment entered is unitless and the resolution is that of the last digit of the frequency displayed (or whichever display is being changed).

The step size is multiplied (or divided) by a factor of ten each time a range is changed to maintain the original step size selected.

The default step size is one unit. The last increment entered is stored and used on each modify operation (of the same parameter) until power-reset.

To display the increment size of each parameter:

#1. Press the SPCL button.

#2. Enter the appropriate number.
- **101** for frequency delta.
- **102** for amplitude delta.
- **103** for offset delta.
- **104** for marker delta (Model 42 only).

Example

To display the step size for the frequency delta:

#1. Press the SPCL button.

#2. Enter 101

STO BUTTON

The STO (Store) button allows front panel setups to be stored in memory for instant recall at a later time. Up to 99 setups can be saved.

Storing Setups

Front panel setups and parameter values (except delta step sizes) can be stored in memory by pressing the **STO** button and then entering a two digit number.

Example

To store the current setup in memory location 5:

#1. Press the STO button.
#2. Enter 05 via the keypads.

Battery Backup

All memory settings are retained in memory when power is removed from the instrument. The length of time that the data will remain stored depends on the condition of the lithium battery installed in the instrument. When fresh, this battery has an approximate life of 5 years.

RCL BUTTON

The RCL (Recall) button allows front panel setups that were previously stored in memory to be recalled for instant setups. Up to 99 setups can be retrieved.

Recalling Setups

Front panel setups and parameter values (except delta step sizes) can be recalled from memory by pressing the **RCL** button and then entering a two digit number corresponding to the memory location in which the setup was stored.

Example

To recall a setup that was stored in memory location 3:

#1. Press the RCL button.
#2. Enter 03 via the keypads.

NOTE: Attempting to recall data from an empty memory location will result in an error message **"ERROR 1-6"**.

LCL BUTTON

The LCL (Local) button removes the instrument from the rear panel IEEE-488 (GPIB) bus control and places it under front panel control. This function can be locked out by the IEEE-488 controller with a "LLO" (local lockout) command.

The instrument is under computer control mode when the LCL button's LED is illuminated.

MODE CONTROLS

The Mode Control section of the instrument includes the CONT, TRIG, and GATE buttons (both Models); and the BURST and I.TRIG buttons (Model 42 only. These buttons allow the operator to select the manner in which the waveforms will be output.

CONT BUTTON

The selected waveform is continuously generated at the programmed frequency.

TRIG BUTTON

One complete cycle of the selected waveform is output when a trigger is input to the rear panel TRIG-IN, GPIB interface, or when the MAN button is pressed.

GATE BUTTON

An output is generated for the duration of the gating signal at the rear panel TRIG-IN connector, or for as long as the MAN button is pressed. The last cycle started is completed.

BURST (Model 42 only)

N cycles of the selected waveform are output for each trigger signal input to the rear panel TRIG-IN, GPIB interface, or each time the MAN button is pressed. See page 6-10 for usage of the N button.

MAN BUTTON

The MAN button is used to enter triggers manually in the TRIG, GATE, and BURST modes.

I. TRIG BUTTON

NOTE: Model 42 only.

Generates internal triggers at the programmed rate for the TRIGGER, GATE and BURST modes. Internal triggers are not allowed in the ARB and SWEEP modes.

The trigger from the input circuit should be a positive slope signal with a threshold level of +2V (factory selected). The threshold level can be changed from -10V to +10V by adjusting a potentiometer inside the instrument.

SYNT BUTTON

The synthesizer option provides a stable output waveform with its frequency locked to an internal quartz crystal.

To operate the synthesizer, simply press the SYNT button. The SYNT button's LED illuminates when the synthesizer is locked, and flashes when unlocked.

If the synthesizer option is not installed in the instrument, an error message "**ERROR 4-1**" appears when the SYNT button is pressed.

IMPORTANT: The synthesizer can be operated in the CONT (continuous) mode only. The frequency range must be within the 4 Hz to 4 MHz range.

ARB BUTTON

NOTE: Model 42 only.

Refer to page 6-15.

RATE BUTTON

NOTE: Model 42 only.

The RATE button selects the internal trigger repetition rate and the data point duration for the ARB and SWEEP modes.

To change the rate, press the **RATE** button, enter the numerical value, and then press the appropriate **ENTER** button for the desired unit.

Example
To enter a rate of 10 mS:
#1. Press the RATE button.
#2. Enter 10
#3. Press the mSEC button.

The programmed rate must be from 0.001 mS to 999.9 seconds.

NOTE: Rate settings such as 0.1 mS must have a zero entered before the decimal point or **ERROR 0-1** will result.

ADDRESS BUTTON

NOTE: Model 42 only.

The ADRS button selects the arbitrary waveform address when entering arbitrary data.

NOTE: The ADRS button is functional only when the arbitrary programming mode is activated by pressing the **SPCL** button and entering **701.**

To select the desired address, press the **ADRS** button, enter the address number, and then press either of the **ENTER** buttons. The address selected will appear in the left window.

Example
To enter address 4
#1. Press the SPCL button.
#2. Enter 701. This enables the editing mode of operation.
#3. Press the ADRS button.
#4. Enter 49
#5. Press either of the ENTER buttons.
#6. Enter SPCL 701 to exit the edit mode.

The data value at the entered address is displayed in the right window. The value can be changed by using the DATA button.

DATA BUTTON

NOTE: Model 42 only.

The DATA button is used to enter the arbitrary data value for the address location displayed in the left window when the ADDRESS button is pressed.

The data value range is from 0 to 3999 (Figure 6-1). Value 2000 corresponds to the zero voltage baseline, 3999 to the maximum positive amplitude, and 0 to the maximum negative amplitude.

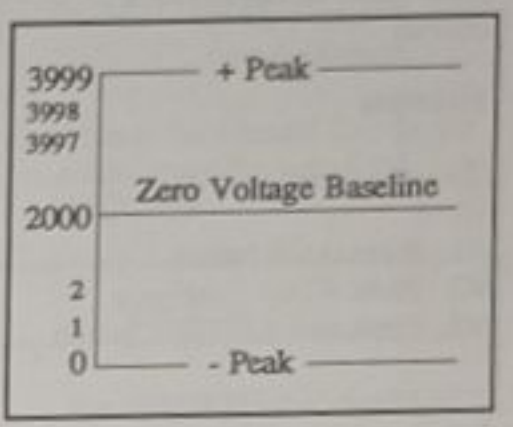

Figure 6-1

To select a new data value, first enter the address location (preceding decription) which is to receive the data value. Next, press the **DATA** button, enter the data value, and then press either of the **ENTER** buttons. The data value selected will appear in the right window.

Example
To select an amplitude value of 2000 (the zero baseline):
#1. Select the address (see the preceding example.
#2. Press the DATA button.
#3. Enter 2000
#4. Press either ENTER button.

THE N BUTTON

NOTE: Model 42 only.

The N button is used in conjunction with the BURST mode. It selects the number of waveform cycles which will be generated when the instrument is triggered. The burst count can be set from 2 to 9999 cycles.

NOTE: The N count default is 2.

To enter the N count, press the N button, enter the count, and then press either of the ENTER buttons.

Example

To enter a count of 17:

#1. Press the N button.
#2. Enter 17
#3. Press either ENTER button.

The N button LED illuminates when the count number is displayed in the frequency window.

SPCL BUTTON

The SPCL (Special) button enables the special functions listed in Table 6-1 to be selected. The special functions listed in Table 6-1 applies to both Models unless otherwise noted.

NOTE: As a quick reminder, all of the special codes are listed on the built-in slide chart underneath the instrument.

To select a special function:

#1. Press the SPCL button.
#2. Enter the appropriate 3-digit number.

The special mode operation is indicated when the SPCL button's LED is illuminated.

SPCL	DESCRIPTION
888	Front panel LEDs and window segments test.
488	The IEEE-488 address is displayed.
601-699	Calibration procedure for maintenance personnel only.
101	Displays the frequency increment magnitude.
102	Displays the amplitude increment magnitude.
103	Displays the offset increment magnitude.
104 •	Displays the marker increment magnitude.
200	Disable and enable frequency locking circuit.
901-999	Internal sweep operation.
701-714 •	Arbitrary programming modes.

• Model 42 only.

INTERNAL SWEEPS

The generator's frequency can be output at either an increasing or decreasing rate (as opposed to a constant frequency) between programmed stop and start frequencies.

#1. Select the STOP frequency:

a. Press the FREQ button.

b. Enter the stop frequency.

c. Press the kHz/V or Hz/mV button.

d. Press the SPCL button.

e. Enter 998.

#2. Select the START frequency:

a. Press the FREQ button.

b. Enter the start frequency.

c. Press the kHz/V or Hz/mV button.

NOTE: After the stop frequency is entered, the sweep range is fixed and the allowable choices for start frequencies are limited. The displayed number of digits for the stop frequency and decimal point location cannot be altered when the start frequency is entered. See Example 6-1 at the right.

When the start frequency is programmed, the ENTER buttons simply enable the numerical frequency entry. Using Example 6-1, the stop frequency display (10.00 kHz) sets the decimal place (two from right), the range (kHz), and the minimum allowable entry for the start frquency (0.01 kHz). For this reason, the example entry start frequency, 100, is actually taken as 1.00 kHz.

#3. Select the step frequency step rate.

Note: A frequency "step" is an increment of one in the least significant decimal place of the displayed frequency, i.e. 1.00 kHz + 1 = 1.01 kHz.

a. Press the SPCL button.

b. Enter a value from 901 (for 10 msec/step) to 990 for (900 msec/step).

The step time (in msec) is obtained by multiplying the last two digits of the entered value by 10 msec.

For example, 905 is equal to 50 msec (05 x 10 msec).

#4. Select the sweep mode.

a. Press the SPCL button.

b. Enter the appropriate number for the sweep mode desired -

- 994 - One single sweep down from stop to start frequency.
- 995 - One single sweep up from start to stop frequency.
- 996 - Continuous sweep down from stop to start frequency.
- 997 - Continuous sweep up from start to stop frequency.

#5. To exit the Internal Sweep mode, enter the command SPCL 999.

RIGHT WAY	WRONG WAY
Enter 10 KHz stop freq: FREQ 10 KHz Display: 10.00 KHz SPCL 998 Enter 1 KHz start freq: FREQ 100 KHz or Hz (either ENTER button works) Display: 1.00 KHz	Enter 10 KHz stop freq: FREQ 10 KHz Display: 10.00 KHz SPCL 998 Enter 1 KHz start freq: FREQ 1 KHz Display: 0.01 KHz

Example 6-1

Internal Sweeps for Model 42 Only

The additional dedicated front panel pushbuttons for sweep control make the Model 42 particularly easy to operate. While the SPCL 901 - 999 codes (page 6-11) work equally well in the Model 41 or Model 42, it is generally preferable to use the Model 42's built-in sweep buttons.

Three possible sweep modes can be activated in the Model 42; linear, logarithmic, and arbitrary. The linear sweep begins at the selected start frequency and progresses through 1000 equal sized frequency steps to the stop frequency. A logarithmic sweep progresses from the start frequency to the stop frequency by moving through 1000 unequal frequency steps; i.e. the initial frequency steps are much smaller (in Hz) than the final frequency steps. The arbitrary sweep mode allows a user defined "waveform" to control the output frequency. As the data values in this "waveform" go up, the output frequency rises and, conversely, as data values decrease, the frequency drops.

The arbitrary sweep "waveform" can have any shape and any number of data values. For all three sweep modes, linear, log, and arbitrary, the time necessary to step through one complete sweep is governed by the selected RATE. The RATE setting is the amount of time necessary to step one frequency interval.

Total sweep time is:
100 x Rate (for linear and log), and A x Rate (for arbitrary, where A = number of points in the arbitrary waveform).

Selecting the Start Frequency

#1. Press START.

#2. Enter the start frequency value.

#3. Press kHz/V or Hz/mV.

Selecting the Stop Frequency

#1. Press STOP.

#2. Enter the stop frequency value.

#3. Press kHz/V or Hz/mV.

Selecting the Rate

#1. Press RATE.

#2. Enter time value.

#3. Press mSEC or SEC.

IMPORTANT: It is necessary to give reasonable consideration to the RATE parameter. If the attempted frequency sweep gives confusing results, the RATE may be too fast. The entire frequency sweep (from START freq. to STOP freq.) may be completed faster than is practical for the output frequencies requested.

Activating Sweeps

#1. Press RUN.

#2. Enter the number corresponding to the chosen sweep pattern.
1 = linear sweep
2 = logarithmic sweep
3 = arbitrary sweep

#3. Enter RUN 0 to stop sweeping or to change a sweep parameter such as start or stop frequency.

NOTE: After entering the RUN command, a short time delay will pass before the sweep output begins.

SWEEP MARKER MODE

Sweeps can be output in a continuous, triggered, gated, or burst mode by pressing the appropriate front panel button.

CONT - Continuous sweep between the start and stop points.

TRIG - One sweep is generated for each trigger signal applied to the rear panel TRIG IN, GPIB interface, or each time the MAN button is pressed.

GATE - Sweeps are generated between the start and stop points for as long as the gating signal is applied to the rear panel TRIG IN BNC, or for as long as the MAN button is pressed.

BURST (Model 42 only) - N sweep cycles are generated for each trigger signal input to the rear panel TRIG IN, GPIB interface, or each time the MAN button is pressed.

To select the number of cycles:

#1. Press the BURST button.

#2. Press the N button.

#3. Enter the desired number of cycles.

#4. Press either of the ENTER buttons.

SWEEP OUT Signal

The rear panel SWEEP OUT BNC provides a signal with the same waveshape as the sweep envelope. This signal can be used for external device synchronization and is particularly useful as the X-input for XY oscilloscope sweep displays. The SWEEP OUT signal voltage depends on the selected start and stop frequencies.

FREQUENCY MARKER

Analysis of a frequency sweep is made much easier by use of a highlighted frequency marker. When viewed on an oscilloscope, the marker appears as a bright line against the blurred background of the swept output. Since the marker can be placed at specified frequencies and moved easily using the MODIFY buttons, it provides an easily recognized visual indication of selected frequencies.

Frequency markers can be viewed with an oscilloscope only in the XY mode of display. The main output of the Model 42 is put into the oscilloscope's Y-input. The SWEEP OUT signal is used to drive the horizontal X-input of the scope. Properly setting the X-input and Y-input voltage ranges will allow the full frequency sweep with the highlighted marker to fully occupy the display.

Selecting the Marker Frequency

#1. Press MKR.

#2. Enter the marker frequency.

#3. Press kHz/V or Hz/mV.

#4. Turn on the sweep mode by entering RUN and the proper code.

NOTE: Arbitrary sweeps cannot have a frequency marker.

MARKER OUT Signal

The rear panel MARKER OUT BNC provides a signal with TTL levels which is time coincident with the programmed marker.

This signal can be used to synchronize external devices, or used as a pen lift signal for XY recorders when the marker is not desired in the plot.

ARBITRARY SWEEPS

Any chosen frequency sweep pattern can be achieved using the Model 42's arbitrary sweep mode. Like linear or logarithmic sweeps, the change in output frequency can be thought of as being controlled by a "waveform" of a given shape.

As the "waveform" magnitude increases, the output frequency also increases. For the simple cases of RUN 1 and RUN 2, the "waveform" shape is a linear or logarithmic ramp.

Entering an arbitrary waveform for arbitrary sweeps is done in precisely the same way as entering an arbitrary waveform for direct output as the actual signal shape. Refer to pages 6-15 through 6-17 for the manual entering and editing process.

With any arbitrary waveform, it is necessary to chose the correct data levels and specify the proper starting and stopping addresses. If the arbitrary sweep waveform can be output and viewed on an oscilloscope, then it is also ready to be used to generate an arbitrary sweep.

Generating an arbitrary sweep with a chosen starting point and carefully selected frequency transitions requires some planning. The starting frequency determines the possible sweep range and fineness of the frequency steps. The data values in the arbitrary waveform determine the actual output frequencies and the ultimate stopping frequency.

Refer to page 6-15 for a description of the possible arbitrary data values.

Planning an Arbitrary Sweep

#1. Set the start frequency by pressing START and entering the chosen frequency.

#2. Based on the displayed numerical value of the start frequency, calculate the necessary data levels needed to produce the required output frequencies. Doing this calculation prevents the problem of choosing starting frequencies incompatible with your overall sweep plan.

For example:

- Select a start frequency of 10.00 kHz.

- Arbitrary data values range from 0 to 3999. Therefore, the maximum possible output frequency is:

  10.00 kHz + 3999 = 49.99 kHz

  To reaffirm the above equation, the answer is truly 49.99 kHz, not 13.999 kHz.

  The least significant digit and the decimal place location remain fixed by the starting frequency.

- If the maximum achievable frequency is acceptable, construct an arbitrary waveform capable of giving the desired sweep.

- Choose a RATE setting which will cause the arbitrary sweep to be output at a speed consistant with the chosen output frequencies.

- Initiate the sweep with the command RUN 3.

ARBITRARY OPERATION

NOTE: Model 42 only.

The operator can design arbitrary waveforms by storing data values into specific random-access memory (RAM) addresses.

The RAM addresses correspond to time (X-axis), and the data values correspond to amplitude (Y-axis), Figure 6-1.

Each of the 2000 RAM addresses (0 - 1999) can store any data value from 0 - 3999.

As illustrated in Figure 6-1,
3999 = max. positive amplitude.
2000 = zero voltage baseline.
0000 = max. negative amplitude.

Example

The waveform illustrated in Figure 6-1 could be duplicated by carefully assigning the proper data values to each of the 2000 RAM addresses. For example, the maximum positive peak of 3999 was programmed into address 1000.

The generator scans the RAM memory with the programmed RATE setting, thus creating the arbitrary output waveform.

NOTE: Output voltages of the arbitrary waveform are determined by the value entered after pressing the AMPL button. See page 6-18, Selecting the Arbitrary Waveform Amplitude.

NOTE: The output frequency is determined by the setting entered after pressing the RATE button. The FREQ button is not functional in the arbitrary mode. See page 6-18, Selecting the Arbitrary Waveform Frequency.

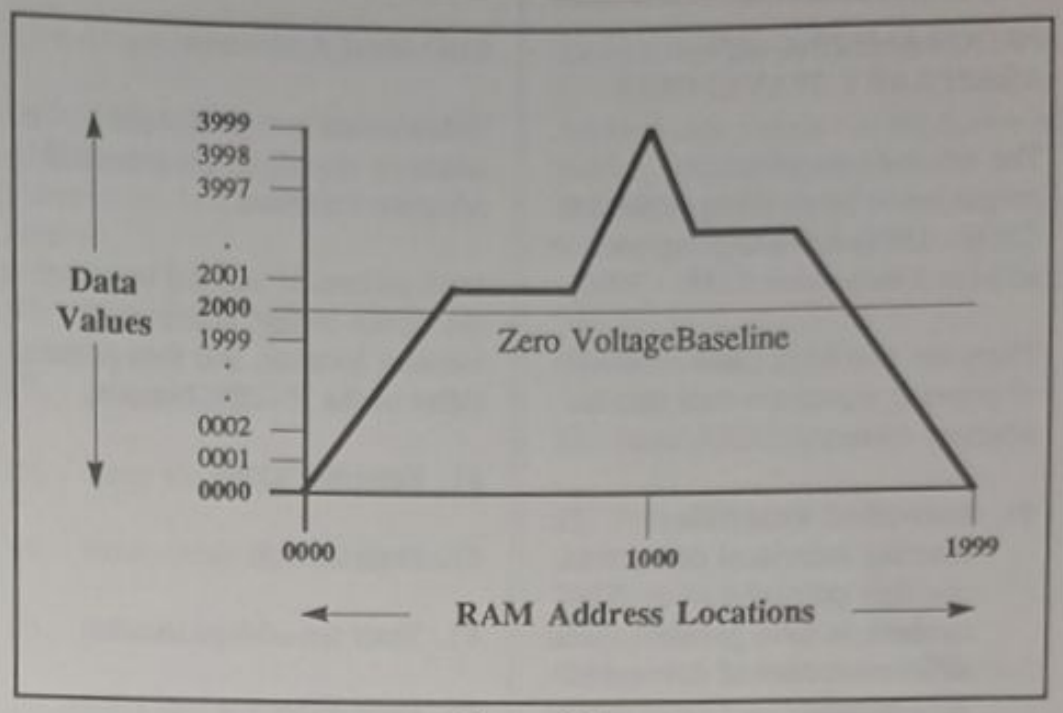

Figure 6-1

Enabling the Arbitrary Waveform Output

The arbitrary mode is activated by pressing the ARB button (LED illuminates).

NOTE: If SPCL 701 (arbitrary editing mode) is turned on, the generator will display an error message when the ARB button is pressed. To turn SPCL 701 off, enter SPCL 701. Similarly, the SPCL button is not functional when the ARB button's LED is illuminated. Pressing the SPCL button while the ARB LED is turned on will cause the error message "**ERROR 0-1**" to appear.

Disabling the Arbitrary Waveform Output

To disable the arbitrary mode, press the ARB button again (LED turns off).

PROGRAMMING AN ARBITRARY WAVEFORM

The arbitrary waveform is programmed by recalling addresses (0000 - 1999) and assigning each address a data value (0000 - 3999).

There are two front panel methods of entering waveform data into the arbitrary memory:

#1. **Individual Entry** for entering individual data points, one data point at a time. This method, in turn, provides three different modes of data entry:
   1) Manual
   2) Auto-increment Addresses
   3) Auto-decrement Addresses

#2. **Line Draw** for entering straight line segments.

Each of these editing modes can be entered or exited by pressing SPCL and the proper 3 digit code. The general edit mode, SPCL 701, must be entered before any addresses or data points can be altered. While in the edit mode, each of the special editing functions can be activated or deactivated by keying in SPCL and the code. The built-in slide chart provides an easy way to remember the various codes.

Arbitrary Editing Codes

SPCL 701 -Enter/Exit editiing
SPCL 702 -Start address
SPCL 703 -Stop Address
SPCL 704 -Auto-increment address
SPCL 705 -Auto-decrement address
SPCL 707 -Line draw

Individual Addresses

This method is typically used when editing a previously programmed arbitrary waveform.

Each address is selected by pressing the ADRS button, entering the memory location, and then pressing either of the ENTER buttons.

#1. Enter SPCL 701.

#2. Press ADRS.

#3. Enter the address location.

#4. Press either ENTER button.

#5. Press DATA.

#6. Enter the data value.

#7. Press either ENTER button

Repeat the above procedure for each address as required.

#8. Enter SPCL 701 to exit the edit mode.

Auto-Increment Addresses

This method is used when programming consecutive address locations. The operator selects the first address, and the generator automatically increments to the next address after each data value has been assigned.

#1. Enter SPCL 701.

#2. Enter SPCL 704.

#3. Press ADRS.

#4. Enter the first address.

#5. Press either ENTER button.

#6. Press DATA.

#7. Enter the data value.

#8. Press either ENTER button.

The generator increments to the next memory address automatically. Repeat steps 9, 10, and 11 for the remaining memory addresses that are to be assigned data values.

#9. Press DATA.

#10. Enter the data value.

#11. Press either ENTER button.

Auto-Increment Off:

#1. Press SPCL.

#2. Enter 704.

Enter SPCL 701 to exit the edit mode.

Auto-Decrement Addresses

This method is used when programming consecutive address locations. The operator selects the first address, and the generator automatically decrements to the previous address after each data value has been assigned.

#1. Enter SPCL 701.

#2. Press SPCL 705.

#3. Press ADRS.

#4. Enter the first address.

#5. Press either ENTER button.

#6. Press DATA.

#7. Enter the data value.

#8. Press either ENTER button.

The generator decrements to the previous memory address automatically. Repeat steps 9, 10, and 11 for the remaining memory addresses that are to be assigned data values.

#9. Press DATA.

#10. Enter the data value.

#11. Press either ENTER button.

Auto-Increment Off:

#1. Press SPCL.

#2. Enter 705.

Enter SPCL 701 to exit the edit mode.

Line Draw

On the Model 42, the LINE DRAW mode enters a straight line segment between the last two addresses entered.

#1. Enter SPCL 701.

#2. Press ADRS.

#3. Enter the first address.

#4. Press either ENTER button.

#5. Press DATA.

#6. Enter the start data value.

#7. Press either ENTER button.

#8. Press ADRS.

#9. Enter the stop address.

#10. Press either ENTER button.

#11. Press DATA .

#12. Enter the data value.

#13. Press either ENTER button.

#14. Enter SPCL 707.
A straight line segment connects the data values in the last two addresses.

#15. Repeat steps 8 - 14 for the next line segment.

Enter SPCL 701 to exit the edit mode.

NOTE: Do not use SPCL 707 to connect two adjacent addresses. This is not needed and spurious results will be generated.

Examining the Addresses

Address data values can be examined quickly by pressing the **UP** or **DOWN** buttons and viewing the windows on the Model 42.

#1. Enter SPCL 701.

#2. Press ADRS.

#3. Press UP or DOWN.

The first ten addresses and corresponding data values are displayed at a slow rate when either button is held in, and then at a faster rate for the remainder.

Enter SPCL 701 to exit the edit mode.

Erasing an Aribtrary Waveform

CAUTION: The following sequence will clear <u>all 2000</u> arbitrary waveform memory addresses.

#1. Enter SPCL 701.

#2. Enter SPCL 706..

#3. Enter SPCL 701 to exit the edit mode.

To replace old data values in memory with new data values, simply reprogram the memory addresses with the new information. The old values will be immediately replaced with the new ones.

Selecting the Arbitrary Waveform Amplitude

The data values assigned to each address are only relative to each other. The actual amplitude voltage levels are selected via the AMPL and numerical keyboard buttons.

Each vertical data level increment is a 2.5 mV output if the instrument's amplitude is set to 9.99V (into 50 ohms). It is proprotionally attenuated for lower output amplitudes (each point will be 1.25 mV if the output amplitude is set to 5V).

To shift the baseline (2000 level) voltage value, use the output offset capabilities of the Model 42.

The output amplitude is selected in the same manner as in the non-arbitrary mode.

#1. Press AMPL.

#2. Enter the amplitude value.

#3. Press either the kHz/V or Hz/mV buttons as required.

NOTE: The amplitude setting is voltage peak-to-peak as in the nonarbitrary mode. Regardless of the actual entered data values, the specified amplitude applies to the full data value range of 0 - 3999. Arbitrary waveforms which do not span the total possible range of data values will not reach the amplitude which was entered. It is important to remember, however, that the allowable amplitude/offset combinations (page 6-5) depend on the programmed amplitude, not on the actual voltages measured at the output.

Selecting the Arbitrary Waveform Frequency

NOTE: The FREQ button is not used for arbitrary waveforms. Rather, the **RATE** button is used to select the point rate (0.001 mS to 999.9 seconds).

The default Point Rate is 0.01 mS.

#1. Press RATE.

#2. Enter the point rate value.

#3. Press either the mSEC or SEC button as required.

Calculating the Arbitrary Waveform Period

The arbitrary waveform's period can be calculated by using Equation 6-1.

$$T_{ARB} = N \times RATE$$

N = Number of addresses comprising the aribtrary waveform.

RATE = Selected point rate.

Equation 6-1

Selecting the Arbitrary Waveform Mode

The arbitrary waveform can be output continuously, triggered, gated, or burst by pressing the appropriate button.

CONT

Continuous outputs are generated.

TRIG

One single waveform is generated for each trigger signal at the rear panel TRIG IN, GPIB interface, or each time the front panel MAN button is pressed.

GATE

Continuously generated waveforms for the duration of the gating signal at the rear panel TRIG IN BNC, or for as long as the MAN button is pressed.

BURST

N waveform cycles are generated for each trigger signal input to the rear panel TRIG IN, GPIB interface, or each time the MAN button is pressed.

To select the number of cycles:

#1. Press BURST.

#2. Press N.

#3. Enter the number of cycles.

#4. Press either ENTER button.

Selecting Partial Arbitrary Waveforms

The operator can select to output a portion of the arbitrary waveform. This will require the selection of start and stop addresses.

Selecting the Start Address:

#1. Enter SPCL 701.

#2. Press ADRS.

#3. Enter the desired Start address.

#4. Press SPCL 702.

Selecting the Stop Address:

#5. Press ADRS.

#6. Enter the desired Stop address.

#7. Press SPCL 703.

Enter SPCL 701 to exit the edit mode.

For example, by changing the stop address, the first cycle of the modified square wave in Figure 6-2 can be selected to be output. This results in the output waveform in Figure 6-3.

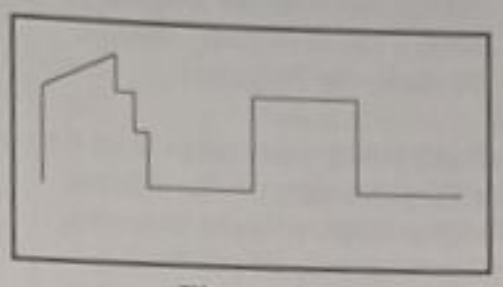

Figure 6-2

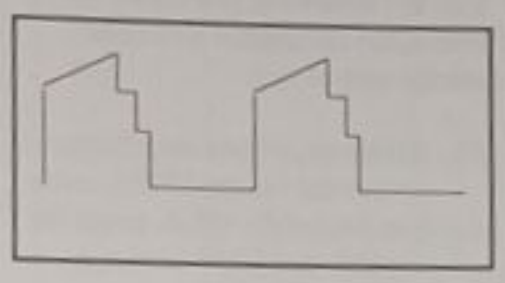

Figure 6-3

Selecting Preprogrammed Arbitrary Waveforms

Five resident waveforms are programmed into the Model 42. These waveforms can be used as is, or modified as required. Each preprogrammed arbitrary waveform will occupy the first 360 addresses if recalled into memory.

NOTE: The ARB button must be turned off to make these selections.

IMPORTANT: The following procedure destroys any arbitrary waveform previously stored by the user in the first 360 arbitrary memory addresses.

#1. Press SPCL.

#2. Enter the appropriate number for the desired waveform.
710 - Sinewave
711 - Squarewave
712 - Triangle wave
713 - Ramp up
714 - Ramp down

#3. Press ARB to output the selected waveform.

Since point by point modification of existing waveforms is quite easy, the various preprogrammed arbitrary waveforms can be used as foundations for creating new, unique arbitrary waveforms.

REAR PANEL I/O

Both Models (41 and 42) are provided with the following rear panel input/output devices, except as noted.

TRIG Input

The TRIG input BNC couples the external trigger or gate signal to the generator.

The trigger level is set to +2V, but is internally adjustable from +10V to -10V.

SYNC Output

The SYNC output BNC provides a symmetrical squarewave signal at the same frequency as the output at the front panel BNC. The output can drive a minimum of 20 TTL loads.

The TTL levels (with a 50 ohm source impedance) are guarded against short circuit damage from any voltage between ±15 VDC.

IMPORTANT: Leads connected to the SYNC OUT should be as short as possible to prevent rounding of the TTL pulse. Reflection from a load connected to the SYNC output will cause ringing if the load is not matched to the inteconnecting cable.

Overshoot and undershoot is less than 10% into a 50 ohm feedthrough termination.

VCO Input

The frequency output of the unit can be swept by connecting a voltage source to the rear panel VCO connector. A positive-going voltage increases the frequency, while a negative-going voltage decreases the frequency.

Input voltages can range from 0 to +5V (depending on the selected sweep range, voltages exceeding this range may be possible).

Use the following procedure to obtain the maximum available sweep range.

#1. Select the sweep stop frequency (press the button FREQ, enter the frequency value, press the Hz/mV or kHz/V button).

#2. Enter SPCL 998.

By using SPCL 998, the lowest allowable frequency which can be reached is equal to the least significant digit of the chosen stop frequency. For example, if the chosen stop frequency is 10.00 kHz, then the lowest possible frequency is 0.01 kHz. Since the maximum possible frequency entry is 3999 (regardless of the range) the largest allowable sweep range (highest freq : lowest freq) is 3999:1. The lowest possible frequency is dependent only on the chosen range and resolution of the stop frequency, not on the keyboard entered start frequency.

NOTE: The maximum possible frequency can exceed the stop frequency by up to a factor of 2 depending on the amplitude of the VCO input.

Enter SPCL 999 to exit from the Range-Lock mode.

AM Input (Model 42 only)

The AM input BNC is used to amplitude modulate (AM) the output. A voltage of 5 Vp-p applied to this input causes 100% modulation

The input impedance is 10 kΩ and is guarded against damage for up to an accidental ±50 V input.

SWEEP Output (Model 42 only)

The internal sweep voltage is available at this output. The source impedance is 600 ohms and is guarded against damage due to a short circuit.

The sweep output magnitude is determined by the sweep start and stop frequencies.

MARKER Output (Model 42 only)

A TTL signal is output at the marker located between the sweep start and sweep stop positions. It can be used to synchronize external instruments, or as a PEN LIFT signal for X-Y recorders.

ARB SYNC Output (Model 42 only)

A TTL signal output at the arbitrary waveform repetition rate which is used to synchronize external instruments to arbitrary waveforms.

The signal is at a logic level "0" and goes high for the RATE point duration at the end of each arbitrary waveform sweep.

ERROR CODES

An error message appears if an invalid key sequence is attempted, or out of range data is entered.

All further instructions are ignored until the error is cleared automatically (after 2 seconds following the error message display, or by pressing a parameter button).

ERROR CODES TABLE

The error codes below apply to both Models unless otherwise noted.

CODE	DESCRIPTION
0-1	Syntax error.
1-1	Data out of range.
1-2	Output amplitude & offset out of limit (see page 6-5).
1-3	Data error (illegal entry).
1-4	Increment range over.
1-5	Decrement range over.
1-6	Empty memory recall.
1-7	Address not available to store setup.
2-0	Special function selected does not exist.
2-5	Sweep operation error.
3-0 **	System mode error.
4-1	Synthesizer option not installed.
4-2	Synthesizer lock error.
5-1	Output protection condition.
5-2 **	Low battery indication.
6-1 **	N count out of range.
6-2 **	Rate out of range.
6-3 **	Arbitrary mode error.
6-4 **	Sweep mode error.
6-5 **	Marker out of range.
6-6 **	Marker delta error.
9-0 *	No communication handshake over IEEE-488 bus.
9-1 *	Syntax error on a IEEE-488 message.

* Model 41 only.
** Model 42 only.

IEEE-488 CONTROLS

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INTRODUCTION

This section provides the information required to program the Model 41 and Model 42 generators via the rear panel IEEE-488 (GPIB) bus connector.

NOTE: All information in this section applies to both Models unless otherwise noted.

GENERAL OVERVIEW OF IEEE-488 (GPIB)

The General Purpose Interface Bus (GPIB) has been widely accepted since April, 1975 when IEEE-488 was published. The GPIB offers interface compatibility which was previously unavailable. Since 1975, thousands of GPIB compatible products have been introduced on the market.

The IEEE-488 (GPIB) bus is specified and described in the IEEE-488 - 1978 standard digital interface for programmable instrumentation. The information in this section assumes that the reader is knowledgeable in GPIB bus communications and has some experience in programming the system.

IEEE-728 STANDARD (the IEEE recommended practice for code and format conventions for use with IEEE-488) is used in programming the Model 41 and 42 Programmable Function Generators.

Both models operate on the GPIB bus as listeners and talkers. The unit listens to messages from the GPIB system controller, and all modes and parameters are programmable. The talk function provides error messages and reports operating modes to the controller.

Physical Limitations

1. Maximum of 15 devices on one GPIB.
2. Maximum of 2 meters of cable between any two devices or 20 meters of cable in total, whichever is less.
3. Maximum data transfer rates are set by the slowest device involved in the transfer. Computer program execution speed is an important factor in data transfer rates.

GPIB Pin Explanation

The following are the explanations of the GPIB pins as they relate to the Nicolet Function Generator.

NOTE: Digital 1 is represented by a low voltage (approximately 0V). Digital 0 is represented by a high voltage (approximately 3V).

D1 through D8: Carry data into or out of the generator. Carry addresses into the generator. Carry specialized controller commands into the generator.

NDAC: Not Data Accepted.
1 = ready to accept data.

NRFD: Not Ready For Data.
1 = not OK to send data.

DAV: Data Valid.
1 = data valid on data lines.

ATN: Attention.
0 = data lines have data.
1 = data lines have address or GPIB command.

IFC: Interface Clear.
1 = "clears" all devices attached to the GPIB so that they are off the GPIB.

SRQ: Service Request.
1 = tells the controlling device that some device on the GPIB has information to be released. To locate the device, a serial polling operation must be conducted by the controller.

REN: Remote Enable.
1 = all devices on the GPIB will ignore their front panel controls and operate strictly under GPIB control.

EOI: End or Identify.
1 = indicates to the device receiving information that the last information to be transmitted is on the data lines.

IEEE-488 Subsets

The IEEE-488 interface function subsets of the generator are: sh1, ah1, t6, l4, le0, te0, sr1, rl1, pp0, dc1, dt1, c0, and e2.

IEEE-488 (GPIB) HARDWARE SETUP

Setting the GPIB Address

Each device that is connected to the GPIB must be assigned a GPIB address.

The generator's GPIB address is determined by an internal register. This register is initialized upon application of power to the instrument by reading the address bits A1-A5 from the GPIB address switch located on the digital board inside the unit (Figure 7-1). This switch is factory preset to decimal 7. The address of the generator can be checked by pressing "SPCL 488". The GPIB address will appear in decimal form in the left window.

To change the address, power off the generator, remove the screws from both sides of the rear cast frame, remove the bottom cover and change the bit settings on the DIP switch to the new values.

Table 7-1 on the next page shows the GPIB DIP switch settings along with the corresponding talk and listen addresses in both decimal and ASCII formats. Be sure to replace the bottom cover and securing screws when you are finished. GPIB addresses range from 0 to 30 (decimal) and must be unique for each device connected to the same bus. Most controllers allow the user to identify devices without regard to the direction of the data flow. Some require the user to specify the device listen address when information is transferred out to the device and the talk address when information is transferred out of the device to the computer.

Check your controller manual to see exactly how your controller works.

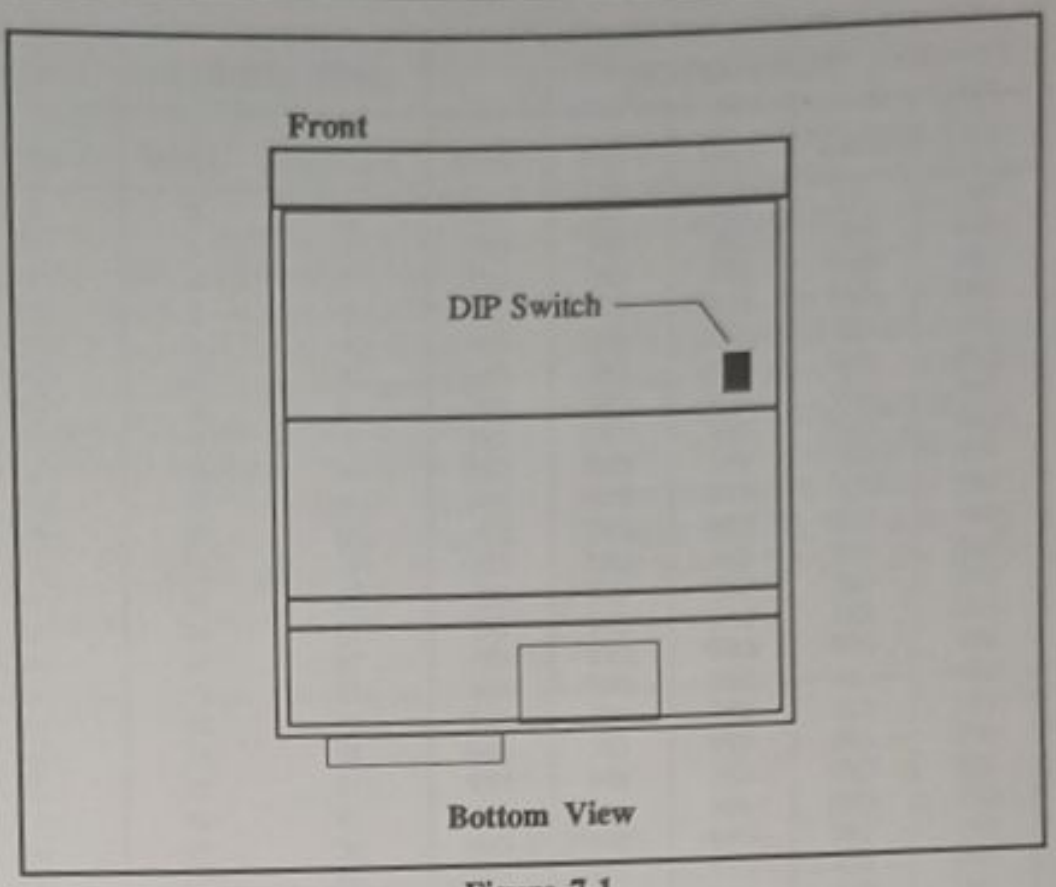

Figure 7-1

DIP SWITCH					GPIB ADDRESS		LISTEN ADDRESS		TALK ADDRESS	
Sw1	Sw2	Sw3	Sw4	Sw5	Decimal	Octal	Decimal	ASCII	Decimal	ASCII
ON	ON	ON	ON	ON	0	0	32	space	64	@
OFF	ON	ON	ON	ON	1	1	33	!	65	A
ON	OFF	ON	ON	ON	2	2	34	"	66	B
OFF	OFF	ON	ON	ON	3	3	35	#	67	C
ON	ON	OFF	ON	ON	4	4	36	$	68	D
OFF	ON	OFF	ON	ON	5	5	37	%	69	E
ON	OFF	OFF	ON	ON	6	6	38	&	70	F
OFF	OFF	OFF	ON	ON	7	7	39	'	71	G
ON	ON	ON	OFF	ON	8	10	40	(	72	H
OFF	ON	ON	OFF	ON	9	11	41	)	73	I
ON	OFF	ON	OFF	ON	10	12	42	*	74	J
OFF	OFF	ON	OFF	ON	11	13	43	+	75	K
ON	ON	OFF	OFF	ON	12	14	44	,	76	L
OFF	ON	OFF	OFF	ON	13	15	45	-	77	M
ON	OFF	OFF	OFF	ON	14	16	46	.	78	M
OFF	OFF	OFF	OFF	ON	15	17	47	/	79	O
ON	ON	ON	ON	OFF	16	20	48	0	80	P
OFF	ON	ON	ON	OFF	17	21	49	1	81	Q
ON	OFF	ON	ON	OFF	18	22	50	2	82	R
OFF	OFF	ON	ON	OFF	19	23	51	3	83	S
ON	ON	OFF	ON	OFF	20	24	52	4	84	T
OFF	ON	OFF	ON	OFF	21	25	53	5	85	U
ON	OFF	OFF	ON	OFF	22	26	54	6	86	V
OFF	OFF	OFF	ON	OFF	23	27	55	7	87	W
ON	ON	ON	OFF	OFF	24	30	56	8	88	X
OFF	ON	ON	OFF	OFF	25	31	57	9	89	Y
ON	OFF	ON	OFF	OFF	26	32	58	:	90	Z
OFF	OFF	ON	OFF	OFF	27	33	59	;	91	[
ON	ON	OFF	OFF	OFF	28	34	60	<	92	\
OFF	ON	OFF	OFF	OFF	29	35	61	=	93	]
ON	OFF	OFF	OFF	OFF	30	36	62	>	94	^
OFF	OFF	OFF	OFF	OFF	DO NOT USE		DO NOT USE		DO NOT USE	
Unlisten/Untalk							63	?	95	_

Table 7-1

INTERFACE COMMANDS

All commands sent to the generator consist of ASCII uppercase character strings without leading or trailing spaces, multiple commands must be separated by a command delimiter in order for the generator to recognize and execute the command.

Delimiters

Delimiters (; or ,) must be used to separate commands appearing in the same input message. An input message is not executed until it is terminated with either a CR and LF, LF only, or by an EOI. Input messages can be a maximum of 128 bytes long.

Data Transfer

Data can be input or output to the Model 42. Each data value consists of 4 ASCII characters (0-9) and ranges in value from 0000 to 3999, with data value 2000 lying on the vertical center of the 42 memory (0 volts). See Table 7-2 for exact syntax for data input and see the interrogate section for output information. Data accepted by the instrument is is accordance with IEEE-728, NR-2 floating point notation.

Errors

The generator will alert the controller that it requires service by sending a SRQ. This service request is also used to indicate an error. After receiving an SRQ, the controller should perform a serial poll and then read the status byte STB) returned by the instrument . This status byte lets the controller know if an error condition exists or if data is waiting to be read by the controller. Error codes are listed in Section 6, page 6-21. The format of the information in the STB is shown in Figure 7-2.

Local and Remote Operation

The generator can be controlled from the front panel (Local) or remotely by a GPIB controller (Remote). The remote mode is entered upon receiving a REN, MLA, or MTA. When in the remote mode the LCL LED is illuminated and all front panel controls are locked out except for the power button and the LCL button. Local control of the instrument can be regained by pressing the LCL button as long as local lockout (LLO) is not in effect.

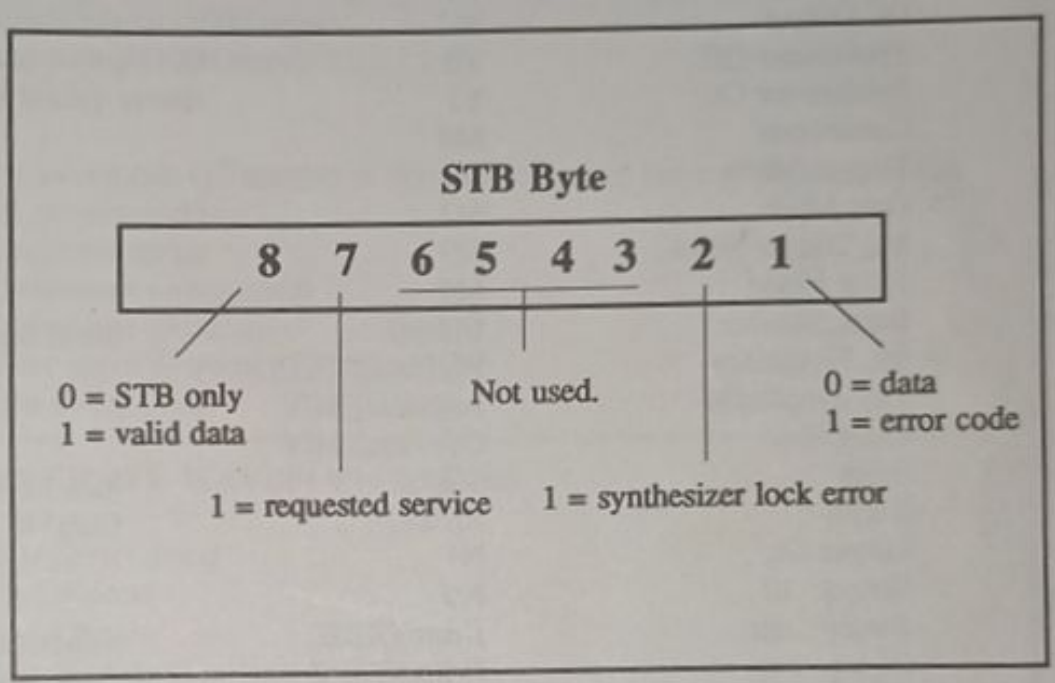

Figure 7-2

FRONT PANEL CONTROLS

Front panel controls can be accessed through the GPIB interface in very much the same way as is done by using the front panel buttons.

CONTROL COMMANDS

COMMAND	ASCII CODE	COMMENTS
Frequency	F[data][K]HZ	values from 0.004 HZ to 3999 KHZ
Amplitude	A[data][M]V	values from 10 MV to 9.99V
Offset	O[data][M]V	values from 0V to 4.49V
Special	Z[data]	any SPCL command see Table 7-3, page 7-9.
Sine Wave	W1	
Square Wave	W2	
Triangle Wave	W3	
DC Output	W4	
Synthesizer Off	Y0	
Synthesizer On	Y1	
Continuous	M0	
Trigger Mode	M1	
Gate Mode	M2	
Int. Trigger Mode	M3	
Burst Mode	M4	
Burst Number	B[data]	[data] from 2 to 9999
Inc. Frequency	F@[data][K]HZ	
Inc. Amplitude	A@[data][M]V	
Inc. Offset	O@[data][M]V	
Store	S[data]	[data] from 00 to 99
Recall	R[data]	[data] from 00 to 99
Output On	N1	
Output Off	N0	
Sweep Start	I[data][K]HZ	values from 0.004 HZ to 3999 KHZ
Sweep Stop	J[data][K]HZ	values from 0.004 HZ to 3999 KHZ
Marker Frequency	K[data][K]HZ	values from 0.004 HZ to 3999 KHZ
Rate	T[data][M]S	values from 0.001 MS to 999.9 S
Linear Sweep	L1	
Log Sweep	L2	
Arbitrary Sweep	L3	
Arbitrary On	X1	
Arbitrary Off	X0	
Arbitrary Address	P[data]	[data] from 0000 to 1999
Arbitrary Data2	Q[data]	[data] from 0000 to 3999
Interrogation	?[command]	any valid command

Table 7-2

SPCL COMMANDS

	MISCELLANEOUS		
	SPCL 101	-	Display frequency Δ value
	SPCL 102	-	Display amplitude Δ value
	SPCL 103	-	Display offset Δ value
	SPCL 104	-	Display marker Δ value
	SPCL 200	-	Frequency locking circuit on/off
	SPCL 488	-	Display GPIB address
	SPCL 888	-	LED test
	INTERNAL SWEEP MODES		
*	RUN 0	-	Sweep off
*	RUN 1	-	Linear sweep (1000 steps)
*	RUN 2	-	Log sweep (1000 steps)
*	RUN 3	-	Arbitrary sweep
	SPCL 901 to 990	-	Set sweep rate (10 ms/step to 900 msec/step, i.e. last two digits x 10 ms)
	SPCL 994	-	Single sweep down
	SPCL 995	-	Single sweep up
	SPCL 996	-	Continuous sweep down
	SPCL 997	-	Continuous sweep up
	SPCL 998	-	Enter upper frequency limit
	SPCL 999	-	Exit sweep mode
	ARBITRARY WAVEFORM MODES		
*	SPCL 701	-	Enter/Exit editing
*	SPCL 702	-	Start address
*	SPCL 703	-	Stop address
*	SPCL 704	-	Auto-increment address
*	SPCL 705	-	Auto-decrement address
*	SPCL 707	-	Line draw
*	SPCL 710	-	Arbitrary sinewave
*	SPCL 711	-	Arbitrary squarewave
*	SPCL 712	-	Arbitrary triangle wave
*	SPCL 713	-	Arbitrary positive ramp
*	SPCL 714	-	Arbitrary negative ramp
*	SPCL 706	-	RESET, all 2000 data values erased.

Table 7-3

*** Model 42 Only.**

INTERROGATION

Most settings on the generator can be interrogated over the GPIB. To interrogate a specific setting simply add the prefix "?" to the mnemonic of the command you wish to interrogate. If the you wish to interrogate a setting that was entered in the programming mode you must first send a "Z701" and then send your "?<command>. For example:

"?F<CR><LF>" will return to you: **"F1000HZ<CR><LF>**

In addition to being able to read a single setting, it is possible to use the "?*", "?! to interrogate the instrument set-up and the arbitrary setup.

After a "?*" the instrument will return the following information on the instrument setup (see Note 1):

F1000HZ;A5.00V;00MV;W1;M0;I1.000HZ;J3999HZ;K0HZ;T0.010MS;B2;N0;Y0;X0;L0<CR><LF>

F1000HZ	Frequency
A5.00V	Amplitude
00MV	Offset
W1	Waveform Function
M0	Trigger Mode
I1.000HZ	Sweep Start
J3999HZ	Sweep Stop
K0HZ	Marker Frequency
T0.010MS	Rate
B2	Burst Number
N0	Output
Y0	Synthesizer
X0	Arbitrary Output
L0	Sweep Run

After a "?!" the generator will return the following information on the arbitrary mode (Model 42 only) (See Note 1):

S0;F10;B0000;E1999<CR><LF>

S0	Arbitrary State (corresponds to the X mnemonic)
F10	Predefined Function (corresponds to the SPCL 710-714 mnemonics)
B0000	Start Address (corresponds to the SPCL 702 command)
E1999	Stop Address (corresponds to the SPCL 703 command).

In order to transfer the contents of an arbitrary address to your controller you must first enter the programming mode on the 42 (SPCL 701) and send a "?PXXXX", where XXXX is the address of interest. After this string is sent, the instrument will return to you the following string (Model 42 only):

P<address>;Q<data><CR><LF>

where <address> and <data> are both 4 digit ASCII number strings.

Note 1: The example shows the values output from the generator if the interrogation was requested after power-up or a DCL.

ASCII CODE CHART

BITS 2^3 2^2 2^1 2^0	2^6=0 2^5=0 2^4=0	2^6=0 2^5=0 2^4=1	2^6=0 2^5=1 2^4=0	2^6=0 2^5=1 2^4=1	2^6=1 2^5=0 2^4=0	2^6=1 2^5=0 2^4=1	2^6=1 2^5=1 2^4=0	2^6=1 2^5=1 2^4=1
0 0 0 0	NUL	DEL	space	0	@	P	`	p
0 0 0 1	SOH	DC1	!	1	A	Q	a	q
0 0 1 0	STX	DC2	"	2	B	R	b	r
0 0 1 1	ETX	DC3	#	3	C	S	c	s
0 1 0 0	EOT	DC4	$	4	D	T	d	t
0 1 0 1	ENQ	NAK	%	5	E	U	e	u
0 1 1 0	ACK	SYN	&	6	F	V	f	v
0 1 1 1	BEL	ETB	'	7	G	W	g	w
1 0 0 0	BS	CAN	(	8	H	X	h	x
1 0 0 1	HT	EM	)	9	I	Y	i	y
1 0 1 0	LF	SUB	*	:	J	Z	j	z
1 0 1 1	VT	ESC	+	;	K	[	k	{
1 1 0 0	FF	FS	,	<	L	\	l	|
1 1 0 1	CR	GS	-	=	M	]	m	}
1 1 1 0	SO	RS	.	>	N	^	n	~
1 1 1 1	SI	US	/	?	O	_	o	delete

Table 7-4

SPECIALIZED GPIB COMMANDS

These commands are all standard to the GPIB. Not all controllers are able to issue all commands. The commands listed below are all supported by the generator. It may be necessary to consult your controller manual on the availability of these functions and the exact syntax to be used.

#1. DEVICE CLEAR (DCL)
This command returns all devices capable of responding to their predefined states. The generator is returned to it's initial power-on state.

#2. SELECTED DEVICE CLEAR (SDC)
Similar to DCL except this command only affects devices addressed.

#3. INTERFACE CLEAR (IFC)
Similar to DCL but this command clears the GPIB. All bus activity ends and all talkers and listeners become unaddressed.

#4. GROUP EXECUTE TRIGGER (GET)
Used to simultaneously trigger a group of devices. On the generator this command acts like the MANUAL trigger button.

#5. GO TO LOCAL (GTL)
Return device to front panel control. On receipt of this command the generator will resume control from the front panel if it previously was locked out by a LLO.

#6. LOCAL LOCKOUT (LLO)
This command locks out front panel control of the addressed device. On the generator all front panel buttons are disabled by a LLO except the power button. To re-enable the front panel the instrument must receive a GTL or be powered down.

#7. REMOTE ENABLE (REN)
Allows all instruments on the bus that are listeners to be programmed by the controller. The generator will switch to the remote mode (LCL button illuminated) upon receiving this command.

#8. UNLISTEN (UNL)
This command unaddresses any active listeners.

#9. UNTALK (UNT)
This command unaddresses an active talker.

#10. MY LISTEN ADDRESS (MLA)
This command is used to address a device as a listener. The generator will switch to the remote mode (LCL button illuminated) upon receiving this command.

#11. MY TALK ADDRESS (MTA)
This command is used to address a device as a talker. The generator will switch to the remote mode (LCL button illuminated) upon receiving this command.

#12. SERIAL POLL ENABLE (SPE)
If a device receives a serial poll enable, it will assert a service request when it requires service. The generator will then assert a SRQ when it needs service or when an error occurs.

#13. SERIAL POLL DISABLE (SPD)
This command stops all addressed devices from sending a SRQ.

SAMPLE PROGRAMS

The following HP-85 and IBM-PC sample programs show the basic usage of the Model 42 interfacing commands. Even if your computer is programmed in a different language, these samples provide help in understand the general format of the commands. Portions of these programs may be used in actual applications.

In order to run the IBM-PC programs, either a National Instruments GPIB-PC board or a CEC board must be installed in the PC. Programs 1-3 use the CEC board, programs 4-6 use the National board. All programs assume that the generator is set to Address 7.

If you have a National Instruments board make sure that the program "**BIB.M**" is in the same directory as your sample program. Also use "**IBCONF**" to name device 7 "**DEV7**".

IBM-PC With CEC Board
PROGRAM #1

```
10    CLS
20    DEF SEG = &HC000
30    INITIALIZE = 0 : SEND = 9
40    TRANSMIT = 3 : RECEIVE = 6 : SPOLL = 12 : ENTER = 21
50    SYSTEM.CONTROLLER% = 0 : MY ADDRESS% = 21
60    ADDR% = 7
70    CALL INITIALIZE (MY ADDRESS%,
      SYSTEM.CONTROLLER%)
80    ST$ = "IFC REN DCL" : CALL TRANSMIT (ST$,
      STATUS%)
90    FOR I = 1 TO 500 : NEXT
100   C$ = "F3KHZ; A2V;W2;S23" + CHR$(13) + CHR$(10)

110   CALL SEND (ADDR%,C$,STATUS%)
120   IF STATUS% <> 0 THEN GOSUB 290 ELSE PRINT
      "A 3KHZ, 2 VOLT SQUARE WAVE IS STORED IN
      LOCATION 23"
130   PRINT : PRINT "TO READ THE DEFAULT SETTINGS
      PRESS RETURN" : INPUT A$
140   C$ = "R00" + CHR$(13) + CHR$(10)
150   CALL SEND (ADDR%,C$,STATUS%)
160   IF STATUS <> 0 THEN GOSUB 290
170   C$ = "?*" + CHR$(13) + CHR$(10)
180   CALL SEND (ADDR%,C$,STATUS%)
190   IF STATUS <> 0 THEN GOSUB 290
200   FOR I = 1 TO 500 : NEXT I
210   CALL SPOLL (ADDR%,POLL%,STATUS%)
220   IF STATUS <> 0 THEN GOSUB 290
230   R$ = SPACE$(80)
240   CALL ENTER (R$,LENGTH%,ADDR%,STATUS%)
250   IF STATUS% <> 0 THEN GOSUB 290
260   IF POLL% = 192 THEN PRINT "DATA: ";R$
270   IF POLL% = 193 THEN PRINT "ERROR = ";LEFT$(R$,2)
280   END
290   IF STATUS% = 8 THEN PRINT "TIMEOUT ERROR" ELSE
      PRINT "GPIB ERROR"
300   RETURN
```

10 Clear the screen
20 CEC initialization

80 Clear the bus

90 Delay
100 Set C$ for a 3KHz, 2V square wave that will be stored in location 23
110 Send C$ to the generator
120 If all went well print "A 3 KHz..." else 290

130 Print and wait for return

140 Recall memory location 0

160 If all went well continue else 290

170 Read set-up information. (interrogation)
190 If all went well continue else 290
200 Delay
210 Serial poll the generator.
220 If all went well continue else 290

240 Get status byte
250 If all went well continue else 290
260 If data, display it
270 If error display, its number
280 End of program
290 Error handling subroutine

IBM-PC With CEC Board
PROGRAM #2

```
10    CLS
20    ON ERROR GOTO 330
30    DEF SEG = &HC000
40    S$ = SPACE$(80)
50    INITIALIZE = 0 : SEND = 9
60    TRANSMIT = 3 : RECEIVE = 6 : SPOLL = 12 : ENTER = 21
70    SYSTEM.CONTROLLER% = 0 : MY.ADDRESS% = 21
80    ADDR% = 7
90    CALL INITIALIZE (MY.ADDRESS%,
      SYSTEM.CONTROLLER%)
100   LOCATE 1,3 : PRINT"*** USE UPPERCASE LETTERS
      (CTRL-BREAK EXITS) ***"
110   ST$ = "IFC REN" : CALL TRANSMIT (ST$,STATUS%)
120   LOCATE 3,1 : PRINT S$ : LOCATE 3,1
130   INPUT "ENTER DEVICE COMMAND >",C$
140   C$ = C$ + CHR$(13) + CHR$(10)
150   LOCATE 5,1 : PRINT S$ : LOCATE 6,1 : PRINT S$
160   CALL SEND (ADDR%,C$,STATUS%)
170   IF STATUS% <> 0 THEN GOSUB 290 : GOTO 120

180   FOR I = 1 TO 500 : NEXT I
190   CALL SPOLL (ADDR%,POLL%,STATUS%)
200   IF STATUS%<>0 THEN GOSUB 290 : GOTO 120

210   IF POLL% < 192 THEN GOTO 120
220   R$ = SPACE(80)
230   CALL ENTER (R$,LENGTH%,ADDR%,STATUS%)
240   IF STATUS% <> 0 THEN GOSUB 290 : GOTO 120
250   LOCATE 5,1 : PRINT S$ : LOCATE 5,1
260   IF POLL% = 192 THEN PRINT "DATA:  "; R$
270   IF POLL% = 193 THEN PRINT "ERROR = ";LEFT$(R$,2)
280   GOTO 120
290   LOCATE 5,1 : PRINT S$ : LOCATE 5,1
300   IF STATUS% = 8 THEN PRINT "TIMEOUT ERROR"
310   IF STATUS% = 2 THEN PRINT "BAD
      COMM.TALK/LISTEN"
320   RETURN
330   PRINT "ERROR NUMBER  ";ERR;"  IN LINE  ";ERL
340   END
```

```
10    Clear the screen
20    On system error goto 330
30    CEC initialization

110   Clear the bus

130   Enter command
140   Add delimiters to the command
150   Clear lines 5 and 6
160   Send command to generator
170   If all went well continue else
      290 then loop back to 120
180   Pause
190   Serial poll the generator
200   If all went well continue else
      290 then loop back to 120
210   If no error and no data loop
      back
230   Get status byte
240   If all went well continue else
      290 then loop back to 120
260   If data, display it
270   If error code, display it
280   Loop Back
290   Error handling subroutine
      (GPIB)

330   Error handling (System)
```

IBM-PC With CEC Board
PROGRAM #3

```
10    CLS
20    DEF SEG = $HC000
30    INITIALIZE = 0 : SEND = 9
40    TRANSMIT = 3 : RECEIVE = 6 : SPOLL = 12 : ENTER = 21
50    SYSTEM.CONTROLLER% = 0 : MYADDRESS% = 21 :
      ADDR% = 7
60    DIM ARB(1999)
70    CALL INITIALIZE (MYADDRESS%,
      SYSTEM.CONTROLLER%)
80    ST$ = : "IFC REN DCL" : CALL TRANSMIT(ST$,
      STATUS%) : IF STATUS% <> 0 THEN 260
90    CLS : PRINT"THE FUNCTION SA(X) WILL BE STORED IN
      ALL 2000 POINTS OF THE ARBITRARY MEMORY OF
      THE 42 (THIS WILL TAKE SOME TIME)."
100   ARB(0) = 3999
110   C$ = "Z701;Z704;P0000;Q3999" + CHR$(13) + CHR$(10)
120   CALL SEND (ADDR%,C$,STATUS%) : IF STATUS <> 0
      THEN 260
130   FOR I = 1 TO 1999
140   ARB(I) = 2000+105947!*SIN(I/53/)I :
      D$ = STR$(INT(ARB(I)))
150   C$ = "Q"+RIGHT$(D$,(LEN(D$)-1))+CHR$(13)+CHR$(10)
160   CALL SEND (ADDR%,C$,STATUS%) : IF STATUS <> 0
      THEN 260
170   NEXT I
180   C$ = "Z704;Z703;PO;Z702;Z701"
190   CALL SEND (ADDR%,C$,STATUS%) : IF STATUS <> 0
      THEN 260
200   PRINT : PRINT"WAVEFORM HAS BEEN COMPUTED
      AND DOWNLOADED INTO THE 42, PRESS RETURN TO
      OUTPUT IT."
210   INPUT A$
220   C$ = "X1;N1" + CHR$(13) + CHR$(10)
230   CALL SEND (ADDR%,C$,STATUS%) : IF STATUS <> 0
      THEN 260
240   PRINT : PRINT"DONE! PROGRAM FINISHED."
250   END
260   IF STATUS% = 8 THEN PRINT  "TIMEOUT ERROR" ELSE
      PRINT"GPIB ERROR"
270   RETURN
```

10 Clear the screen
20 CEC initialization

60 Dimension array for the function to be input.

80 Clear the bus

100 Set value of first data point

110 Put the 42 into the edit mode, with auto increment on.
130 Loop
140 Calcualte Sa(I) for point for I and make $0 \leq Sa(x) \leq 3999$ for all x
150 Send the data point to the 42 (no spaces can be sent)

170 Loop back
180 Set start and stop points and return to normal mode

210 Wait for return
220 Output the arbitrary waveform

250 Program End
260 Error handling subroutine

IBM-PC With National Instruments Board
PROGRAM #4

```
10    CLEAR  ,60000!
20    IBINIT1 = 60000!
30    IBINIT2 = IBINIT1 + 3
40    BLOAD "BIB.M", IBINIT1
50    CALL IBINIT1 (IBFIND, IBTRG, IBCLR, IBPCT, IBSIC,
      IBLOC, IBPPC, IBBNA, IBONL, IBRSC, IBSRE, IBRSV,
      IBPAD, IBSAD, IBIST, IBDMA, IBEOS, IBTMO, IBEOT,
      IBRDF, IBWRTF)
60    CALL IBINIT2 (IBGTS, IBCAC, IBWAIT, IBPOKE, IBWRT,
      IBWRTA, IBCMD, IBCMDA, IBRD, IBRDA, IBSTOP,
      IBRPP, IBRSP, IBDIAG, IBXTC, IBRDI, IBWRTI, IBRDIA,
      IBWRTIA, IBSTA%, IBERR%, IBCNT%)
70    CLS
80    NM$ = "DEV7"
90    V% = 1
100   CALL IBFIND(NM$, NIC42%)
110   CALL IBSIC(NIC42%) : CALL IBSRE(NIC42%,V%) : CALL
      IBCLR(NIC42%)
120   FOR I = 1 TO 500 : NEXT
130   C$ = "F3KHZ;A2V;W2;S23" + CHR$(13) + CHR$(10)


140   CALL IBWRT (NIC42%,C$)
150   PRINT "A 3KHZ, 2 VOLT SQUARE WAVE IS STORED IN
      LOCATION 23"
160   PRINT : PRINT"TO READ THE DEFAULT SETTINGS
      PRESS RETURN" : INPUT A$
170   C$ = "R00" + CHR$(13) + CHR$(10)
180   CALL IBWRT (NIC42%,C$)
190   C$ = "?*" + CHR$(13) + CHR$(10)
200   CALL IBWRT (NIC42%,C$)
210   FOR I = 1 TO 500 : NEXT
220   CALL IBRSP (NIC42%,POLL%)
230   R$ = SPACE$ (80)
240   CALL IBRDA (NIC42%,R$)
250   IF POLL% = 192 THEN PRINT "DATA:  ";R$
260   IF POLL% = 193 THEN PRINT "ERROR = ";LEFT$(R$,2)

270   END
```

```
10    National board initializaton

      (Lines 10 through 60 MUST be
      included in your program.)

70    Clear the screen
80    Name the device

100   Find the device
110   Reset everything

120   Delay
130   Set C$ for a 3KHz,2V square
      wave that will be stored in
      location 23
140   Send C$ to the generator

170   Recall memory location 0

190   Read set-up information.
      (interrogation)
210   Delay
220   Serial poll the generator.

240   Get status byte
250   If there's data display it
260   If there was an error display it's
      number
270   End of program
```

IBM-PC With National Instruments Board
PROGRAM #5

```
10    CLEAR  ,60000!
20    IBINIT1 = 60000!
30    IBINIT2 = IBINIT1 + 3
40    BLOAD "BIB.M", IBINIT1
50    CALL IBINIT1 (IBFIND, IBTRG, IBCLR, IBPCT, IBSIC,
      IBLOC, IBPPC, IBBNA, IBONL, IBRSC, IBSRE, IBRSV,
      IBPAD, IBSAD, IBIST, IBDMA, IBEOS, IBTMO, IBEOT,
      IBRDF, IBWRTF)
60    CALL IBINIT2 (IBGTS, IBCAC, IBWAIT, IBPOKE, IBWRT,
      IBWRTA, IBCMD, IBCMDA, IBRD, IBRDA, IBSTOP,
      IBRPP, IBRSP, IBDIAG, IBXTC, IBRDI, IBWRTI, IBRDIA,
      IBWRTIA, IBSTA%, IBERR%, IBCNT%)
70    CLS
80    ON ERROR GOTO 290
90    S$ = SPACE$(80)
100   V% = 1
110   NM$ = "DEV7"
120   CALL IBFIND(NM$,NIC42%)
130   CALL IBSIC(NIC42%) : CALL IBSRE(NIC42%,V%)
140   LOCATE 1,3 : PRINT"*** USE UPPERCASE LETTERS
      (CTRL-BREAK EXITS) ***"
150   LOCATE 3,1 : PRINT S$ : LOCATE 3,1
160   INPUT "ENTER DEVICE COMMAND >",C$
170   C$ = C$ + CHR$(13) + CHR$(10)
180   LOCATE 5,1 : PRINT S$ : LOCATE 6,1 : PRINT S$
190   CALL IBWRT(NIC42%,C$)
200   FOR I = 1 TO 500 : NEXT I
210   CALL IBRSP (NIC42%,POLL%)
220   IF POLL% < 192 THEN GOTO 150
230   R$ = SPACE$(80)
240   CALL IBRDA (NIC42%,R$)
250   LOCATE 5,1 : PRINT S$ : LOCATE 5,1
260   IF POLL% = 192 THEN PRINT "DATA:  ";R$
270   IF POLL% = 193 THEN PRINT "ERROR = "; LEFT$(R$,2)
280   GOTO 150
290   PRINT "ERROR NUMBER "; ERR;"   IN LINE  ";ERL
300   END
```

```
10    National board initializaton

      (Lines 10 through 60 MUST be
      included in your program.)

70    Clear the screen
80    On system error goto 290

110   Name the device
120   Find the device
130   Clear the bus

150   Clear line 3
160   Enter command
170   Add delimiters to the command
180   Clear lines 5 and 6
190   Send command to generator
200   Pause
210   Serial poll the generator
220   If no error and no data, loop back

240   Get status byte
250   Clear line 5
260   If data, display it
270   If error code, display it
280   Loop Back
290   Error handling subroutine (GPIB)
300   Program end
```

IBM-PC With National Instruments Board
PROGRAM #6 (Model 42 Only)

```
10    CLEAR  ,60000!
20    IBINIT1 = 60000!
30    IBINIT2 = IBINIT1 + 3 'Lines 10 through 60 MUST be included
      in your program"
40    BLOAD "BIB.M", IBINIT1
50    CALL IBINIT1 (IBFIND, IBTRG, IBCLR, IBPCT, IBSIC,
      IBLOC, IBPPC, IBBNA, IBONL, IBRSC, IBSRE, IBRSV,
      IBPAD, IBSAD, IBIST, IBDMA, IBEOS, IBTMO, IBEOT,
      IBRDF, IBWRTF)
60    CALL IBINIT2 (IBGTS, IBCAC, IBWAIT, IBPOKE, IBWRT,
      IBWRTA, IBCMD, IBCMDA, IBRD, IBRDA, IBSTOP,
      IBRPP, IBRSP, IBDIAG, IBXTC, IBRDI, IBWRTI, IBRDIA,
      IBWRTIA, IBSTA%, IBERR%, IBCNT%)
70    CLS
80    NM$ = "DEV7"
90    V% = 1
100   CALL IBFIND(NM$, NIC42%)
110   CALL IBSIC(NIC42%) : CALL IBSRE(NIC42%,V%) : CALL
      IBCLR(NIC42%)
120   DIM ARB (1999)
130   CLS : PRINT "THE FUNCTION SA(X) WILL BE STORED IN
      ALL 2000 POINTS OF THE ARBITRARY MEMORY OF
      THE 42. (THIS WILL TAKE SOME TIME.)"
140   ARB(0) = 3999
150   C$ = "Z701;Z704;P0000;Q3999" + CHR$(13) + CHR$(10)
160   CALL IBWRT (NIC42%, C$)
170   FOR I = 1 TO 1999
180   ARB (I) = 2000 + 105947!*SIN(I/53)/I : D$ =
      STR$(INT(ARB(I)))
190   C$ = "Q" + RIGHT$(D$,(LEN(D$)-1)) + CHR$(13) +
      CHR$(10)
200   CALL IBWRT(NIC42%,C$)
210   NEXT I
220   C$ + "Z704;Z703;P0;Z702;Z701" + CHR$(13) + CHR$(10)
230   CALL IBWRT(NIC42%,C$)
240   PRINT : PRINT"WAVEFORM HAS BEEN COMPUTED AND
      DOWNLOADED INTO THE 42, PRESS RETURN TO
      OUTPUT IT"
250   INPUT A$
260   C$ = "X1;N1" + CHR$(13) + CHR$(10)
270   CALL IBWRT(NIC42%,C$)
280   PRINT : PRINT "DONE!  PROGRAM FINISHED."
290   END
```

10 National board initializaton

70 Clear the screen
80 Name the device

100 Find the device
110 Reset everything

120 Dimention array for the function to be input.

140 Set value of first data point
150 Put the 42 into the edit mode, with auto increment on.
170 Loop
180 Calcualte Sa(I) for point for I and make $0 \leq Sa(x) \leq 3999$ for all x
190 Send the datapoint to the 42 (no spaces can be sent)

210 Loop back
220 Set start and stop points and return to normal mode

250 Wait for return
260 Output the arbitrary waveform

290 Program end

HP-85 PROGRAM #1

```
10    RESET 7
20    CLEAR 707
30    CLEAR
40    FOR I = 1 TO 100
50    NEXT I
60    C$ = "F3KHZ;A2V;W2;S23"

70    OUTPUT 707 USING "K"; C$
80    DISP "A 3 KHZ, 2 VOLT SQUARE WAVE IS STORED IN
      LOCATION 23"
90    DISP
100   DISP "TO READ DEFAULT SETTINGS PRESS RETURN"
110   INPUT A$
120   C$ = "R00"
130   OUTPUT 707 USING "K" ; C$
140   C$ = "?*"
150   OUTPUT 707 USING "K" ; C$
160   FOR I = 1 TO 100
170   NEXT I
180   P = SPOLL(707)
190   ENTER 707; S$
200   IF P = 192 THEN DISP "DATA:  ";S$
210   IF P = 193 THEN DISP "ERROR = ";S$

220   END
```

```
10    Reset I/O
20    Reset the generator
30    Clear the screen
40    Delay

60    Set C$ for a 3KHz, 2V square
      wave that will be stored in
      location 23
70    Send C$ to the generator


110   Wait for Return
120   Recall memory location 0

140   Read set-up information.
      (interrogation)
160   Delay

180   Serial poll the generator.
190   Get status byte
200   If there's data display it
210   If there was an error display its
      number
220   Program end
```

HP-85 PROGRAM #2

```
10    RESET 7
20    REMOTE 707
30    CLEAR
40    DISP "ENTER DEVICE COMMAND (USE CAP'S ONLY)
50    INPUT C$
60    OUTPUT 707 USING "K" ; C$
70    FOR I = 1 TO 100
80    NEXT I
90    P = SPOLL (707)
100   IF P < 192 THEN 30
110   ENTER 707; S$
120   IF P = 192 THEN DISP "DATA:  ";S$
130   IF P = 193 THEN DISP "ERROR = "; S$
140   DISP "PRESS RETURN TO CONTINUE"
150   INPUT A$
160   GOTO 30
170   END
```

```
10    Reset I/O
20    Set generator to remote operation
30    Clear the screen

50    Enter command
60    Send command to generator
70    Pause

90    Serial poll the generator
100   If no error and no data loop back
110   Get status byte
120   If data display it
130   If error code display it

150   Wait for return
160   Loop back
170   Program end
```

HP-85 PROGRAM #3

```
10   CLEAR 707
20   RESET 7
30   REMOTE 707
40   CLEAR
50   DIM A(1999)
60   DISP "THE FUNCTION SA(X) WILL BE STORED IN THE
     ARBITRARY MEMORY OF THE 42."
70   A(0) = 3999
80   C$ = "Z701; Z704; P0; Q3999"
90   OUTPUT 707 USING "K";C$
100  FOR I = 1 TO 1999
110  A(I) = 2000 + 105947*SIN(I/53)/I
120  D$ = VAL$(INT(A(I)))
130  D$ = "Q"&D$
140  OUTPUT 707 USING "K"; D$

150  NEXT I
160  C$ = "Z704;Z703"
170  OUTPUT 707 USING "K"; C$
180  C$ = "P0;Z702;Z701"
190  OUTPUT 707 USING "K"; C$
200  DISP
210  DISP "WAVEFORM HAS BEEN COMPUTED AND
     DOWNLOADED INTO THE 42, PRESS RETURN TO
     OUTPUT IT."
220  INPUT A$
230  C$ = "X1;N1"
240  OUTPUT 707 USING "K"; C$
250  DISP "DONE! PROGRAM FINISHED"
260  END
```

10 Reset I/O
20 Reset the generator
30 Set generator to remote operation
40 Clear the screen
50 Dimention array for the function to be input.

70 Set value of first data point
80 Put the 42 into the edit mode, with auto increment on.
100 Loop
110 Calcualte Sa(I) for point for I and make $0 \leq Sa(x) \leq 3999$ for all x

140 Send the datapoint to the 42 (no spaces can be sent)
150 Loop back
160 Set start point

180 Set stop point and return to normal mode

220 Wait for Return
230 Output the arbitrary waveform

260 Program end

SPECIFICATIONS

The specifications apply for instruments operating at 25°C ±5°C ambient temperature, at 0V offset, and after 30 minutes warm-up. Specifications are measured into 50 ohms load.

GENERAL (Both Models, except as noted)

Memory:	Non-volatile, stores up to 99 complete instrument settings.
Power Requirements:	90 - 126 V, 180 - 256 V switch selectable, 48 - 66 Hz, single phase, 50 VA max.
Dimensions:	115 mm (H), 290 mm (W), 340 mm (D)
Weight:	4 kg net (NIC-41), 4.5 kg net (NIC-42)

WAVEFORMS

Model 41:	Programmable sine, square, triangle, and DC.
Model 42:	Programmable sine, square, triangle, positive ramp, negative ramp, pulse, ARB-waveform, and DC.

OPERATING MODES (Both Models, except where noted)

CONTINUOUS:	Output continuous at programmed frequency.
TRIGGERED:	Generates one cycle at the programmed frequency when triggered by an external signal, GPIB trigger, manual trigger, or internal trigger (Model 42 only).
GATED:	Same as the TRIGGERED mode, except the output is activated for the duration of the gate signal. The last cycle started is completed.
MODIFY:	Frequency, amplitude, and offset can be manually incremented/decremented with a predetermined number of counts. The step rate is 500 mS for each first 10 steps, and then 100 mS for successive steps when the UP/DOWN button is held pressed in.
MODULATION:	Generator can be frequency (Models 41 and 42) and amplitude (Model 42 only) modulated.
SWEEP (41 only):	Internal linear sweep with programmable start and stop frequencies, up or down, step size and rate. Maximum sweep ratio = 3999:1 Rate range is 10 mS to 990 mS for one step with 10 mS resolution.
SWEEP (42 only):	Internal, programmable start, stop, rate and marker frequency. Linear, logarithmic and user-defined sweep shapes can be continuous, triggered, gated, or burst selected.
BURST (42 only):	Same as TRIGGERED mode for programmed number of cycles from 2 to 9999.

Specifications are subject to change without notice.

OUTPUT CHARACTERISTICS (Both Models, except as noted)

Amplitude Range:	10 mV - 10V peak-to-peak into 50 ohms. 20 mV - 20V peak-to-peak into open circuit.
Amplitude Resolution:	3 digits. 1 mV from 10 mV to 999 mV, and 10 mV from 1.0V to 9.99V.
Amplitude Accuracy:	±2% of programmed value and ±20 mV for output. 1.0V - 10V ±3% and 10 mV - 99 mV ±5 mV for sinewave output at 1 kHz.
Repeatability:	Model 41: ±1% for 24 hours. Model 42: ±1% ±20 mV for 24 hours.
Amplitude Flatness:	0.5 dB to 400 kHz, 2 dB to 4 MHz for 1V - 10V output.
Offset Range:	From -5V to +5V into 50 ohms (-10V to +10V into open circuit) Absolute peak amp. + offset limited to 5V into 50Ω (10V into open circuit)
Offset Resolution:	3 digits. 1 mV when peak-to-peak amplitude is less than 999 mV. 10 mV when peak-to-peak amplitude is more than 1.0 V.
Offset Accuracy:	±0.5%, ±20 mV in DC function.
Output Impedance:	50 ohms ±2%.
Output Protection:	The instrument is designed to be non-destructively protected against short circuit or accidental AC/DC voltages of up to 100V applied to the front panel OUTPUT BNC.

WAVEFORM CHARACTERISTICS (Model 41 and Model 42)

Sine Distortion:	Less than 0.6% THD (40 Hz to 39.99 kHz). Less than 1% THD (10 Hz to 100 kHz).
Triangle Linearity:	98% to 100 kHz.
Time Symmetry:	±1% (40 Hz to 399 kHz).
Square Transition Time:	Less than 50 nS.
Square Over/Undershoot:	Less than 5% of peak-to-peak amplitude, ±20 mV.

INTERNAL TRIGGER (Model 42 only)

Range:	0.001 mS to 999.9 Sec.
Resolution:	4 digits
Accuracy:	0.01%

Specifications are subject to change without notice.

ARBITRARY CHARACTERISTICS (Model 42 only)

Functions: User defined, or internal preprogrammed sine, square, triangle, ramp up, and ramp down with 0.01% frequency accuracy. From 0.004 mHz to 1 kHz.

Horizontal Resolution: 2000 points.

Vertical Resolution: 12 bits.

Point Duration: 0.001 mS to 999.9 Sec with 4 digit resolution, 0.1% accuracy.

INPUTS and OUTPUTS (Both Models, except as noted)

Protection: Inputs designed to be protected against up to ±50V input.

VCO Input: 0-5V for up to 1000:1 frequency change.
Input impedance = 10 kΩ.

Trigger In Input: 2V level, factory selected (internally adjustable to ±10V).
Input Impedance = 10 kΩ
Maximum rate = 4 MHz
Minimum width = 50 nS

Sync Output: TTL level square wave at programmed frequency.
Output Impedance = 50 ohms
Sync out designed to be protected against short circuit and up to ± 15V accidental input.

Sweep Output: Model 42 only. Source impedance 600 ohms, same waveshape as sweep selected.

ARB. Sync. Output: Model 42 only. TTL level, 50 ohms impedance.

AM Input: Model 42 only. Impedance of 10 kΩ, 5 V peak-to-peak for 100% modulation.
Bandwidth: DC to 20 kHz minimum.

Marker Output: Model 42 only. TTL level signal, time coincident with programmed marker.

SWEEP (Model 42 only)

Sweep Time: 0.001 mS to 999.9 Sec per point, 4 digit resolution with 0.01% accuracy,
1 sweep equals 1000 points.

Sweep Width: 4000:1 maximum, start and stop must be in the same range.

Sweep Ranges: 0.004 Hz - 3.999 Hz, 0.01 Hz - 39.99 Hz and so on until 1 kHz - 3999 kHz.

Specifications are subject to change without notice.

FREQUENCY CHARACTERISTICS (Model 41 and Model 42)

RANGE:	0.004 mHz to 4 MHz.
RESOLUTION:	3-3/4 digits (3999 counts).
ACCURACY:	±0.2% of reading (40 Hz to 3999 kHz) in continuous mode. ±5% of reading on other frequencies and modes.
JITTER:	Less than 0.1%.
STABILITY:	±0.2% in continuous mode. ±0.2% for 10 minutes, ±0.5% for 24 hours in other modes.
REPEATABILITY:	±1% for 24 hours in other than continuous mode.

GPIB PROGRAMMING (Model 41 and Model 42)

IEEE-488 (GPIB):	Compatible, non-isolated.
Address:	0 - 30 internal switch selectable.
Subsets:	SH1, AH1, TS, TE0, L3, LE0, SR1, PP0, DC1, C0, E2
Interface Timing:	Parameters = 10 mS. Function and Mode = 5 mS Others = 10 mS

Specifications are subject to change without notice.

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